The Australian and New Zealand
JOURNAL OF SURGERY

Vol. 28 — No. 2 NOVEMBER, 1958

BRIEF HISTORY OF PEPTIC ULCER SURGERY

By W. W. Woodward

Launceston

ONLY a life-span ago, in 1881, Billroth did the first successful partial gastrectomy. Despite the advent of Listerism and anaesthesia abdominal surgery before that year amounted to little more than ovariotomy, and simple excision of the gall-bladder was not introduced till the following year.

It must be one of the most ancient observations that skin will unite with nearby skin. But what led Billroth to believe that he could unite stomach to intestine?

Forerunners in intestinal suture

Part of the answer had been provided about a half-century earlier when Lembert described the sero-muscular suture which still bears his name (Garrison and Morton, 1954); that was in 1826. Ten years later Dieffenbach published the first account of an intestinal resection in which Lembert's suture was successfully used (Garrison and Morton). Eleven years later, in 1847, Dieffenbach's chair in Berlin was taken by Bernhard von Langenbeck, whose assistant Billroth became (Garrison, 1929). Hence it is possible that Billroth heard through Langenbeck of Dieffenbach's success with the Lembert suture.

Origin of partial gastrectomy

The remaining steps to gastrectomy have been so well traced by Gordon-Taylor *et alii* (1929) that quotation will best serve the reader's interest.

". . . the real foundations of gastric surgery were laid by the considerable experimental work of Gussenbauer and Winiwarter. who worked with dogs in Billroth's clinic in Vienna. Their research was undertaken in order to find the best method of coaptation of the unequal segments resulting from removal of the pyloric end of the stomach. The junction was commenced by performing a preliminary suture, sometimes of the greater, sometimes of the lesser curvature of the stomach, and was completed by a circular suture of the duodenum to the thereby narrowed gastric segment. The modern surgeon still appreciates the difficulties accompanying this anastomosis. . . . A careful study of Billroth's publications shows that the possibility of removing the human stomach for malignant disease was ever in his mind, and he approached the subject logically, step by step. Thus the cure of a gastric fistula described in 1877 proved to him that the human stomach could be sutured without digestion of the stitches taking place. At the end of this paper he remarked upon the successful results of his pupils Gussenbauer and Winiwarter in their animal experiments; this knowledge, together with that derived from his successful suture of the human stomach, convinced him that gastrectomy in the human subject should be possible in the near future. He said: 'It only requires a bold step forward from this operation to achieve the resection of a portion of the stomach affected by carcinomatous degeneration.' In the year 1879 he discussed the successful resection of intestine, and the reader gathers that he had definitely made up his mind with regard to human gastrectomy, for, instead of saying that the operation would be a 'bold step,' he said: 'It must succeed, though of course one ought to begin with a simple and not too extensive case'."

Based on a paper read to the Section of History of Medicine at the *Australasian Medical Congress (B.M.A.)*, Hobart, 1958.

Billroth's success took place two years after the publication of a partial gastric resection for a pyloric tumour by the Parisian ovariotomist, Jules Péan (Walters, 1949), who only five years before was one of the introducers of the modern artery forceps (Power, 1927; Castiglioni, 1941). Péan's partial gastrectomy patient had three blood transfusions but died five days after the resection (Gordon-Taylor *et alii*).

Like Péan, Billroth removed the pyloric antrum and re-established continuity by end-to-end suture of the stomach to the duodenum. In French and Belgian accounts of this operation, the term Péan-Billroth is still used (Deloyers, 1956) and Péan's name is sometimes applied to the operation by Anglo-American writers (Tanner, 1956; Walters, 1949).

Billroth's communication took the form of an open letter in the local medical press the week after the operation. This was addressed to a certain Dr. L. Wittelshofer who had apparently cast doubt upon the justification of the operation (Illingworth, 1953). Thus in Vienna the partial gastrectomy aroused immediate interest.

Fate of partial gastrectomy with gastro-duodenal anastomosis

Billroth used this operation for cancer, but the same year Rydygier of Poland, and the following year Billroth's pupil, Vincenz Czerny, used it for ulcer (Robson and Moynihan, 1901).

Two deaths followed the first three Billroth I operations. Later in a scholarly yet practical textbook on operative surgery, regarded by Garrison as "an index of his great learning," Kocher wrote: "The weak spot of the operation is the point where the occluding suture of the upper portion of the stomach wound joins the anastomosing suture lower down, for it is difficult to obtain secure closure without causing tension."

Billroth soon introduced another operation. In this the jejunum was joined to a stoma in a side wall of the stomach's stump, partial gastrectomy with latero-lateral gastro-jejunostomy. This was reported only four years after the earlier operation, that is in 1885, by von Hacker (Gordon-Taylor *et alii*). Subsequently the two operations have been called the Billroth I and II partial gastrectomies. Kocher noted that Mikulicz had a lower mortality after the Billroth I than the Billroth II but the operations were then being used more for cancer than for ulcer, and it is likely that the Billroth I was done for the less extensive lesions. Lahey (1942) called the Billroth I the "safest" partial gastrectomy for ulcer, because all manipulations are above the transverse colon thus sparing the small bowel, but this is a view by no means universally taken nowadays. Both operations have become modified, an adequate Billroth I operation these days consisting of a much more extensive gastric resection than in the early pyloro-antrectomies.

Von Haberer was one of the first to revive the Billroth I operation but later abandoned it (Kinsella, 1956). However, in von Haberer's clinic, only the pars pylorica and the first part of the duodenum were excised (Orator, 1928). This left so much acid-secreting stomach that ulcer recurrence was inevitable; indeed the operation as described by Orator was no more than what Ogilvie (1947) dubs "pyloric circumcision."

That the extent of resection governs ulcer recurrence after a Billroth I is well shown by Capper and Welbourn (1954) whose findings for duodenal ulcer are these: if less than 70 per cent. of the stomach is removed, recurrent ulceration is over four times commoner after gastro-duodenal than after gastro-jejunal anastomoses, whereas if 70 per cent. or more is removed there is no difference in recurrence rates. For gastric ulcer on the other hand they believe that a limited (50 per cent.) resection of the Billroth I type is not only adequate but unsurpassable. These authors also confirmed that dumping, bilious vomiting, weight loss, steatorrhoea, colic and diarrhoea are all less common after resection with gastro-duodenal than with gastro-jejunal anastomosis. So is sideropenic anaemia (Wallenstein, 1955; Thomson, 1957a). Tanner (1951) found dumping to follow gastro-duodenal and gastro-jejunal anastomoses equally, but after the latter it lasted longer.

As a result of experimental work, Harkins believes that the entrance of acid into the duodenum reflexly reduces gastric secretion,

whereas the entrance of alkaline duodenal secretion through a gastro-jejunal stoma into the stomach increases acid secretion (Harkins, 1954). All these findings favour the modern extended Billroth I.

Thus, with due care to prevent necrosis at the "danger angle," and with extension of the resection to reduce the size of the acid-secreting area, the Billroth I operation has regained favour in England and North America (Grey Turner in Devine, 1940; Moloney, 1954; Capper and Welbourn, 1954; Walters, 1956). From Scandinavia also, a review of 1,256 partial gastrectomies of both types showed that the extended Billroth I procedure is preferred for gastric ulcer in both men and women, and for suitable duodenal ulcers in women (Odelberg, 1954).

The eponymous Billroth II

When Budapest was being besieged by the Russians in December, 1944, there suddenly disappeared from his home the Hungarian surgeon, Eugen (Jëno) Alexander Polya, son of a well-known economist. This distinguished surgeon's fate since then is unknown. Morton and Garrison, and the writers of the two obituaries listed below, remarked that his body was not recovered but that it was assumed he had been abducted and killed by a Nazi group.

Thirty-three years earlier, Eugen Polya had sponsored a modification of the Billroth II operation. He publicized termino-lateral anastomosis of stomach stump to jejunum. William Mayo's son-in-law, Waltman Walters, has translated Polya's comments on priority (Walters, 1949). Polya said that he first found this a way out of difficulties, but soon came to see it as a method of choice. He made plain that it was von Hacker who first advocated the idea of connecting the opening of the stomach's stump directly with the jejunum, and that it was Krönlein in 1888 who first performed such an operation (ante-colic) and that since then many surgeons including von Eiselsberg, Mikulicz, Doyen and Hofmeister had published reports of cases in which the principle of termino-lateral gastro-jejunostomy was followed with various alterations in technique (ante-colic, retro-colic, narrowed and un-narrowed gastric stump). Walton (1923) records that Sir James Sherren also independently thought out and performed the operation in 1910, the year before Polya publicized it. Polya himself only claimed that he called this procedure to the attention of the surgical world and particularly to that of William Mayo who saw in it, Polya said, the operation of the future and whose support of it helped to bring a large following. But von Hacker, as an eponym, is hardly euphonious in an English or American operating room. Hence there Polya's name is likely to survive, at least for as long as the operation itself.

One reason for modifying the Billroth II was that as resection was extended proximally to excise larger growths, less room became available for the fashioning of a separate stoma. Another was that the gastro-jejunostomy had occasionally devitalized the portion of gastric stump between stoma and closed end.

Polya recommended that an opening be made in the transverse mesocolon for the jejunum. Hence his operation was retro-colic. Argument has continued as to whether an ante- or retro-colic anastomosis is the better. Doyle (1951) followed Krönlein and Balfour in performing an ante-colic anastomosis and this is the site preferred by Tanner (1955), who points out that it lengthens the afferent limb by no more than an inch. Furthermore, of 75 internal herniae occurring after gastrectomy, 55 followed retro-colic, and 15 ante-colic anastomoses (Morton *et alii*, 1955), though of 16 collected by Stammers (1954) 15 followed ante-colic anastomoses.

Applied to closure of the upper cut end of the stomach are the eponyms Hofmeister and Finsterer. Hofmeister described partial gastric closure in 1908, and Finsterer in 1913. Both, incidentally, made retro-colic anastomoses. But it was in 1888 that von Eiselsberg first narrowed the stoma, and he described this in a publication the next year (Thorek, 1938; Walters, 1949). His anastomosis was ante-colic. As von Eiselsberg's name is uneconomically polysyllabic, it was perhaps too much to hope for its general use. His priority, however, was recognized by Doyle (1951). In favour of the partial stoma, Lahey remarked that anastomosis between jejunum and the entire open end of the stomach offers a greater chance of leakage than an anastomosis only one-third of that length. Probably

a more telling difference is that the shorter cut in the jejunum makes a shorter operation by giving less bleeding. In post-operative barium studies, Lahey made the interesting observation that when two-thirds of the open cut end of the stomach is closed, the gastric content remains longer above the stoma. This should allow fuller gastric digestion before infliction of the food upon the jejunum. The incidence of "dumping" is reduced by a valved stoma in the opinion of Tanner (1956).

Gradual spread of partial gastrectomy

In parts of Europe under Viennese surgical influence, partial gastrectomy for ulcer became established during this century's first two decades (Ogilvie, 1928). But in France, England and North America, acceptance, to say the least of it, came more tardily.

In 1925, for example, Berg of the Mt. Sinai Hospital, New York, himself a lonely but forceful protagonist, wrote: "Other surgeons in Germany, one in England, several in Austria, followed the lead of von Haberer and adopted this procedure of partial or subtotal gastrectomy." The one in England would have been Moynihan, whose acceptance of resection with termino-lateral gastro-jejunostomy for gastric but not duodenal ulcer will shortly be shown.

Kinsella describes as follows the efforts made by Finsterer of Vienna to have partial gastrectomy adopted in England: "In 1926 Finsterer attended the annual meeting of the B.M.A. in Nottingham and advocated gastrectomy for ulcer. Unfortunately he also attempted to demonstrate his highly specialized techniques torn from the proper setting in which they had been elaborated, and met with failure, as have others in like circumstances. In 1928, he added a personal appeal to Hurst on behalf of this operation. He reported that gastrectomy could be done even for the so-called inoperable ulcers penetrating liver and pancreas (if the viscera were separated and the base of the ulcer left behind), and that, even including these, since 1919 he was able to achieve a mortality of 2.6 per cent in 532 patien's (4 per cent. in the 175 gastric cases and 2 per cent. in the 357 duodenal cases), 87 of them between sixty and seventy-eight years of age. In support he quoted von Eiselsberg's mortality of 3 per cent. in 449 patients. These two surgeons were indeed worthy disciples of their great master, Billroth. But Finsterer met with a cold reception."

Kinsella notes that the reports from an English teaching hospital "revealed a primary mortality, from 1919 to 1931, of 16.9 per cent. in partial gastrectomy for peptic ulcer."

This difference in mortality was good reason, even if there had been no other, for the cautious view of the operation that was taken in England. The modern low mortality at the hands of fully trained English gastrectomists shows that similarly it would have been good reason for regarding training in gastric surgery as a special branch. Indeed lack of uniformity in the results of the operation has caused Kinsella to make this plea as late as 1956.

In further tracing the increasing use and acceptance of partial gastrectomy it is necessary to separate duodenal, gastric and stomal ulcer.

Of its use in duodenal ulcer Hurst in 1929 described partial gastro-duodenectomy (partial gastrectomy plus resection of the first part of the duodenum) as ". . . formidable and the mortality is likely to be so high that it is very improbable that it will ever gain wide popularity. In a recent discussion on the surgical treatment of ulcer C. H. Mayo said: 'If any man wanted to cut out half of my good stomach in order to cure a little ulcer of my duodenum, I would run faster than he,' and I think that most reasonable people under the same conditions would wish to run with him. According to Moynihan 'gastrectomy for duodenal ulcer is neither safe nor simple, nor does it bring an adequate reward . . . We know the worst of gastro-enterostomy, the best is unsurpassable; we have yet to learn the worst of gastrectomy, though what we know is bad enough.' Moreover, it is impossible to be certain that the gastric contents will be alkaline after the operation unless almost the whole stomach is removed." The surgeons of the Mayo Clinic operate for only one duodenal ulcer in seven (Walters, 1956). Hence Charles Mayo's and Berkeley Moynihan's aversions have stood the test of time in the

matter of uncomplicated duodenal ulcer. Nevertheless, if an otherwise fit man's duodenal ulcer causes stenosis or unmanageable pain, bleeds repeatedly or perforates repeatedly, then of all treatments adequate partial gastrectomy makes the closest approach to cure (Ogilvie, 1947; Capper and Welbourn, 1954; Odelberg, 1954; Tanner, 1955; Walters, 1956). Though the Mayo Clinic offers no surgery to six out of seven, nearly always the seventh receives partial gastrectomy (Walters, 1956).

As for gastric ulcer, Moynihan in 1928 wrote from Leeds: ". . . by degrees I was brought to realize that gastric ulcer was a far more serious disease than duodenal ulcer . . . The operation that I regard with the utmost confidence as thoroughly satisfactory for the great majority of cases is gastrectomy. There are very few cases in which it cannot be performed. It is safe to a degree that one could hardly expect. In ten consecutive years the mortality has been 1.6 per cent. . . ." Moynihan's lead, at first viewed guardedly (Rowlands and Turner, 1927; Ogilvie, 1928), nevertheless was being followed by English surgeons (Walton, 1923; Carson, 1924) in gradually increasing numbers. In Rochester, Minnesota, W. J. Mayo, brother of Charles, was giving the same lead. At the Mayo Clinic partial gastrectomy remains the operation for gastric ulcer and is used for two out of every three chronic recurring gastric ulcers (Walters, 1956).

Similarly for stomal ulcer after gastroenterostomy, surgeons at the Mayo Clinic have provided statistical evidence to justify the increasing use of partial gastrectomy (Walters *et alii*, 1955).

To sum up on partial gastrectomy, Ogilvie (1947) stated that the operation in experienced hands has a mortality not exceeding 2 per cent, a cure rate of at least 90 per cent., and an incidence of recurrent ulceration of at most 1 per cent. He added, however, that because in average clinics the risks of gastrectomy are four or five times as high and the prospects of cure less assured, alternative treatments are constantly sought.

Some alternative treatments

(1) *Limited excisions.* Local or simple excision (described by Judd and Rankin, 1923), wedge and sleeve excisions (described by Walton, 1923), cautery excision (introduced by Balfour, 1914) and transgastric excision (described by Mayo, 1910) were put forward for use alone or with short-circuits as double-barrelled shots. Combined or alone, these excisions make little or no attempt to reduce the ulcer-producing secretion of the gastric glands. Recurrent ulcers brought their downfall. For a poorly nourished man with a short history of aversion to meat, the writer once chose an excision limited but with wide margins for a gastric ulcer later shown histologically to be benign but still at operation under suspicion of malignancy. Ulceration recurred inside seven months. The recurrence was over one inch in diameter, deep and chronic in its features, with callous walls according to a report from another city; for not altogether surprisingly, the patient took his second ulcer away. After nine local excisions a famous abdominal surgeon in London, Sherren, had to re-operate for six recurrent ulcers (Sherren, 1922). Sherren, incidentally, had a master mariner's ticket before he began the study of medicine. Later, at the height of his fame and powers, he returned for the rest of his days to the sea (Power and Le Fanu, 1953). There as ships' surgeon he did much for the medical welfare of sailors and no one supposes that the change was due to his experience of local excision!

(2) *Pyloroplasty.* A plastic operation on the pylorus was first described in 1886 by Heinecke and the next year independently, so all authors affirm, by Billroth's pupil, Mikulicz. They incised the pylorus horizontally and sutured the opening vertically.

In 1901 Mayo Robson and Berkeley Moynihan, whose biographies appear in Power and Le Fanu, wrote this: "As our experience of pyloroplasty increases, we are inclined to place less reliance upon it as a therapeutic measure . . . cases which have been brilliantly successful in their immediate results have shown after the lapse of eighteen months, two years or longer, a tendency to relapse . . . Pyloroplasty must not be performed where there is active ulceration or moderate or extensive induration, or adhesions the result of peripyloritis. In those cases where narrowing of the outlet occurs after pyloroplasty it is probable that the operation has been contra-indicated from the first, though experience to guide us at the

time was lacking. As the prohibitive restrictions we have mentioned are present in the majority of cases, it necessarily follows that the role of pyloroplasty is a limited one. Though this opinion is contrary to that of many surgeons, we feel convinced that it will be shared by all who can watch for years the careers of their patients. Berg (*Brit. Med. J.*, August, 1900) has abandoned the pyloroplasty for gastro-enterostomy in cases of pyloric stenosis on account of this tendency to recurrence of the stricture." As they foresaw, pyloroplasty came to grief. But we still close any enterotomy thus and, after horizontal antro-duodenotomy in search for bleeding ulceration, close vertically if at all.

(3) *Short circuits.*

(a) Gastro-duodenostomy. In 1892 Jaboulay introduced gastro-duodenostomy (Walton). Mathieu Jaboulay was a versatile Frenchman. He was the first to report a successful interilio-abdominal amputation, though an unreported success had been obtained by Billroth three years before; he wrote an authoritative monograph on the sympathetic nervous system and collaborated in another on the thyroid (Garrison). The fate of gastro-duodenostomy will be given below.

(b) Finney's operation. In 1902 a different and remarkable gastro-duodenostomy was devised. Early in his career, J. M. T. Finney was W. S. Halsted's chief assistant at Johns Hopkins Hospital, Baltimore. Not only one of America's ablest surgeons, Finney was also a great man. Osler hailed him as the "man with head, heart and hand."

Finney's operation survives in the gastric surgeon's repertoire for it occasionally helps in dealing with a stenosing perforated duodenal ulcer. It then prevents post-operative gastric obstruction (Tanner, 1955), other solutions being partial gastrectomy or, in women and older men, gastro-jejunostomy. The principle of Finney's operation finds almost ubiquitous application. Afferent and efferent jejunal limbs can be united Finney-wise to make a pouch for food after a too radical gastric resection. This is latero-lateral jejuno-jejunostomy so infrequently used that perhaps it hardly needs a less cumbersome title but mercifully it has one, jejunoplasty. The writer has once seen it demonstrated for the relief of post-gastrectomy distress declared to have had origin in the afferent jejunal limb.

Further afield the method finds urologic recognition in widening a narrowed pelviureteral junction (Hanley, 1957) and very like Finney's, except that the loops of suture material are of course on the outside, is the sew-up after crescentic excision of a suitable aortic coarctation (Walker and Haxton, 1954).

The judgment of Kocher (1911) was this: "Heinecke and Mikulicz have attempted to dilate the stenosed pylorus by excising it in its longitudinal axis and stitching it up in a transverse direction. The ultimate results, however, are neither so effective nor so certain as gastro-duodenostomy and the immediate results are in no way more satisfactory. With Finney's operation, on the other hand, a sufficiently wide pyloric opening can be obtained. He does not confine himself to mere division of the stenosis, but prolongs the incision into the stomach and the duodenum, and unites the cut edges of both all round right up to the pylorus and thus provides a wide communicating channel."

Of 84 patients on whom a famous American modifier of the Billroth I had, instead of that operation, done pyloroplasties only one-third remained asymptomatic (Horsley, 1930).

Pyloroplasty and gastro-duodenostomy both aimed at relieving the obstruction and/or pylorospasm accompanying a nearby ulcer. They did not lower acidity. Recurrent ulcers brought them down (Walters, 1956).

(c) Jejunostomies.

(i) Gastro-jejunostomy. The Viennese of 1881 saw not only the first successful gastrectomy but also in the same year the first successful gastro-jejunostomy — by Billroth's pupil Wölfler (Garrison and Morton). Usage favours the term gastro-enterostomy, but gastro-jejunostomy is more precise. Like partial gastrectomy, gastro-jejunostomy was first used for cancer, but still in the same year Courvoisier made an unsuccessful attempt to use this short-circuit for ulcer (Ogilvie, 1947). Eleven years later, in 1892, Eugène Doyen of Paris used gastro-jejunostomy successfully for chronic gastric ulcer. In 1894, when Doyen first published his paper, this

patient was still free from symptoms. Doyen then wrote that he had short-circuited the upper alimentary tracts of fourteen additional patients with gastric ulcer. Interestingly in view of the fate of gastro-jejunostomy, these were free from obstruction (Hurst and Stewart, 1929).

Wölfler's was an anterior gastro-jejunostomy, but four years later, that is in the same year as the Billroth II was reported, von Hacker introduced posterior gastro-jejunostomy (Walton).

Short-circuiting relieves obstruction and rests the diseased part if that is distal to the short-circuit. It is relatively easy to do and its mortality is low. But early acclaim led to an evil name. As indications broadened then became common bad results, "vicious circle" vomiting and recurrent ulcers.

(ii) Jejunostomy. As early as 1901 Robson and Moynihan wrote: "Cases of peptic ulcer in the jejunum after gastro-enterostomy are recorded . . . Under such conditions, Neumann suggests that the operation of jejunostomy should be performed." Twenty-six years later Rowlands and Turner had still to record that jejunostomy retained a distinct place in the treatment of very grave cases of gastric ulcer where other operations were too serious, particularly where there was extensive ulceration of the upper stomach or much adhesion to neighbouring viscera. Under such circumstances jejunostomy had often been life-saving, a more radical operation being carried out when the patient's health had improved (Rowlands and Turner).

(iii) Pyloric occlusion plus gastro-jejunostomy. The observation that a good result followed gastro-jejunostomy if done for obstruction led on to what now seems a strange procedure, for in deference to this observation surgeons deliberately strictured the pylorus. Indeed controversy arose as to what the best material to ensure permanence of this occlusion (Walton). Though somewhat bizarre by modern standards, this was not without a logical basis. Pyloric occlusion if complete would keep acid off a duodenal ulcer and tend to deviate food through the gastro-jejunal stoma, were no misfortune of site, size or stricture from stomal ulcer to cause vomiting instead.

Ulceration recurrent after gastro-jejunostomy

By 1925 Berg had found that 30 per cent. of gastro-jejunostomies were followed by recurrent ulcer and furthermore recorded that secondary operations to overcome this sequel produced, up to that year, a mortality of no less than 15 per cent. Bad reports soon became common (Hertz, 1913; Sutton, 1916; Moynihan, 1920). Indeed Pribram (1924) was credited with having called gastro-enterostomy a disease. In this present decade Tanner (1955) has reported a ten-year follow-up on gastro-jejunostomies done for duodenal ulcer in 1943. Over 50 per cent. developed stomal ulcers.

However, Tanner goes on to say that varying recurrence rates may result from differing diagnostic standards. He adds that Sir James Walton in a follow-up of 896 patients extending from 1919 to 1944 found recurrent ulcers in only 4 per cent.

Similarly, forty years' experience of gastro-jejunostomy for duodenal ulcer at the Mayo Clinic revealed recurring ulceration in only about 5 per cent. despite changing indications for the operation during that time (Walters, 1956).

Furthermore, Clark's (1951) follow-up has shown that ulceration recurrent after gastro-jejunostomy in women of any age and in men over fifty is practically as infrequent as after partial gastrectomy. Hence with careful selection gastro-jejunostomy still has a role in duodenal ulcer treatment (Illingworth). Walters (1956) agrees that (1) men in the older age groups, particularly if they have obstructing duodenal ulcers, (2) women with obstructing duodenal ulcers, and (3) patients for whom the risk of death from partial gastrectomy would be increased above what it is ordinarily (1.5 per cent. in his experience) are all suitable for gastro-jejunostomy. Walters adds that the possible deciding factors in regard to (3) above would be: (i) coronary artery disease, (ii) subnutrition from prolonged duodenal obstruction, or (iii) an ulcer too large to leave in the course of a partial gastrectomy without fear of leakage of duodenal, biliary or pancreatic juices from the closed duodenum.

Gastro-jejunostomy also plays a well-known "drainage" role for vagotomy. The value of the vagotomy is not easy to assess because

gastro-jejunostomy alone will heal duodenal ulcers; and will keep them healed unless they are re-activated by an obstructed gastro-enteric stoma resulting from a gastro-jejunal ulcer (Walters, 1956).

To sum up, the survival of gastro-jejunostomy in the treatment of duodenal ulcer has depended upon the above re-narrowing of its indications.

(4) *Exclusion operations.* Von Eiselsberg in 1895 introduced pyloric exclusion with the object of allowing duodenal ulcer to heal in the absence of food and acid. Jejunal ulcers brought disappointment. The secretions of the entire stomach were deviated into the jejunum and this was considered the cause of the jejunal ulcers (Balfour, 1935).

In 1910 von Eiselsberg introduced antral exclusion. The principle of resting an inflamed peri-ulcerous region was followed upon occasion by Finsterer but he removed the antrum out of fear that it would stimulate acid gastric secretion (Balfour, 1935).

In 1906 Edkins showed that the antral mucosa produces a substance which stimulates the glands of the fundus and body to discharge acid and pepsin. It is possible that this substance, now known to be distinct from histamine, causes recurrent ulcers after antral exclusions. Whether this substance is a hormone or a secretagogue absorbed by the antral mucosa remains in dispute.

Sir Huge Devine adopted antral exclusion in the early 1920's because he took heed of the early post-operative dangers of gastro-duodenectomy for technically difficult duodenal ulcers. Exclusion carried "less than half the operative risk" of gastro-duodenectomy. "The curative effects of partial gastric exclusion were about the same as partial gastrectomy where two-thirds or more of the stomach was removed" (Devine, 1940).

The upper gastric resection in Devine's exclusion makes the gastric part of the operation as extensive as an ordinary two-thirds partial gastrectomy, and there is great virtue in leaving an inflamed, tethered pyloric, duodenal or stomal ulcer well alone at a first operation (Balfour, 1935; McKittrick *et alii*, 1944. Six to eight weeks after exclusion inflammation will have subsided (Tanner, 1951). The antrum can then be safely removed along with its notorious mucosa unless this has already been completely cored out.

Devine also recommended exclusion in the treatment of gastro-jejunal ulcer. Daryl Lindsay's illustrations in Thorek (1938) and Devine (1940) show the operation as used for each condition.

Antral exclusion still finds a rare, non-ulcerous use in palliating non-resectable cancer of the stomach's lower third. If the growth is bulky then the flaps must be capacious, as in any amputation. The decision to leave the antrum must be made before its blood vessels are tied; otherwise the antrum will slough (Edwards, 1948), because the blood vessels to the duodenum do not cross the pylorus (Ogilvie, 1952).

In 1940 Devine warned that the incidence of jejunal ulcer following exclusion-resection might prove higher than had been expected. This was particularly likely if exclusion was combined with a less than adequate gastric resection. Later Tanner (1955) without specifying the extent of resection wrote that the incidence of recurrent ulcer exceeded 20 per cent. Three out of twenty-three merely hemi-gastric exclusions have been followed by stomal ulcers in less than six months (Kay, 1956). Devine further warned that the operation was, of course, contra-indicated in the presence of pyloric stenosis severe enough to prevent free drainage of antral mucus. Though no longer sole therapy, the operation finds the above occasional yet invaluable use as a first-stage procedure for ulcer, and a modification has been described recently by Quist (1958).

(5) *Division of parasympathetic nerves.* Pavlov's sham feedings could produce gastric secretion only when the vagi were intact. His book was published in London in 1910 and the following year Exner advocated the therapeutic use of vagotomy. Vagotomy was re-introduced in 1922 by Latarjet (Allen, 1947), in 1930 by Pieri and Tanferna (Walters, 1955), and more effectively because of a surer transthoracic neurotomy, by Dragstedt and Owens in 1943 (Dragstedt, 1945).

Per-hiatal division of the vagi from below (Orr and Johnson, 1947) allows abdominal access for the necessary concomitant drainage operation, i.e. gastro-jejunostomy, gastro-duodenostomy or pyloroplasty. Of these pyloroplasty is Tanner's choice (Tanner, 1950), but Walters (1956) says that this is followed by antral spasm, and prefers gastro-jejunostomy. Dragstedt too combines vagotomy with posterior gastro-jejunostomy (Tanner, 1956). As Illingworth observes, the success or failure of double-barrelled attacks can be attributed at will to either component. Long-term results of one such combination have recently been published by Burge and Pick (1958).

Vagotomy's eventual place is unsettled. Like some of the other alternatives to gastric resection, it waxed lustily but quickly waned. Currently vagotomy holds a role for ulcer recurrent after adequate gastric resection (Ogilvie, 1947; Walters, *et alii*, 1955).

(6) *Division of vessels and sympathetic nerves.* Somervell of Travancore, in an operation called "physiological gastrectomy," ligates five out of every six vessels on the greater curvature commencing as far up as can be reached from a paramedian incision without pulling on the stomach. He ligates the vessels to the lesser curve *en masse*, but spares those to the pylorus and to the antrum within an inch of it. Somervell then adds gastro-enterostomy, thus making his operation double-barrelled (Somervell, 1945).

Hey of Manchester, who had introduced vaso-ligation, later wrote that Somervell's ligations were inadequate. He said that the operation done by Somervell was no more nor less than a gastro-enterostomy and that the terms "physiological gastrectomy" and "Somervell's operation" should be dropped (Hey, 1947). In "over one thousand operations in sixteen years" he had ligated all vessels from oesophagus to pre-pyloric region. Hey claimed the results to be very much better than those of gastro-jejunostomy but not as good as those following high partial gastrectomy. He said that vaso-ligation would cure anastomotic ulcer. The benefits he claimed came not from devascularization but from sympathetic denervation allowing the vagi to cause rapid gastric emptying. Accordingly, to provide a hurdle against regenerating nerve fibres, Hey encircled each vessel with four non-absorbable ties.

Hence the aim of the originator was the exact opposite of that of vagotomy. The writer has seen only one vaso-ligated stomach but never seen the operation performed, nor its name on an operating list.

(7) *Washing the stomach with alkali.*

(a) Cholecyst-gastrostomy. To alkalize stomachs, gall-bladders were drained into them. It is surer and safer to give alkali by mouth (Hurst and Stewart).

(b) Aylett's operation. Aylett (1951) made a more sophisticated attempt at washing the stomach with alkali. He divided jejunum, joined the pyloric region to the distal jejunum, and implanted proximal jejunum high into the gastric stump so that alkali would run down over the gastric mucosa. Aylett (1953) defended the operation against criticism by Ogilvie (1953), but the next year withdrew his proposal because 7 out of 104 patients had developed recurrent ulceration, thus defeating the object of the operation. Three of these 7 were enjoying good health when they perforated without preliminary pain, the absence of which was ascribed to the lowered acidity produced by the operation (Aylett, 1954). Thereupon Ogilvie (1954) congratulated Aylett on publishing his adverse results, an event which he said was too rare in surgical literature.

(8) *Intestinal interpositions.* Moroney's colonic, and Henley's small bowel interpositions (1953) aimed at restoring alimentary continuity at the time of wide gastric resection. Ulcers recurred after not less than 7 per cent. of these operations (Walters, 1956). Hence for primary treatment surgeons have avoided both. Some, however, have used interposition to combat subnutrition after total gastrectomy, but this is considered inferior to Roux en-Y oesophago-jejunostomy (Balint and Gummer).

Small bowel or colon interposition has been put to a further use — to regain a gastro-duodenal path for food and secretions when prolonged dumping complicates a gastrectomy with gastro-jejunal anastomosis. More reliable, if surgery has to be undertaken at all, is

conversion of the gastro-jejunal into a gastro-duodenal anastomosis without interposition (Tanner, 1956).

(9) *Recent innovations.*

(a) Antral preservations. Wangensteen's (1956) segmental resection with antral preservation in continuity and Deloyers' (1956) "reversed" gastrectomy are recent introductions. They extend earlier operations.

Mikulicz in 1898 first introduced segmental resection. Though hour-glass constriction as a complication had been reported (Carson, 1924) von Eiselsberg (1914) had never seen an ulcer recurrent after it, while Stewart and Barber (1916) from experiments in dogs claimed that segmental resection interfered with gastric motility less than did wedge resection. Segmental resection was recommended also by Erwin Payr of Leipzig in 1910 (Walters, 1956). Wangensteen acknowledges that his is "really the old Mikulicz procedure in a new dress." As in Deloyers' "reversed" gastrectomy, Wangensteen aims at removing acid-secreting upper stomach while preserving the mucus-secreting antrum in continuity. At intervals this idea is revived. A similar proposal was made by Connell (1938), whose fundusectomy proved inadequate for duodenal ulcer (Tanner, 1957). Preserving the antrum in continuity is said to have none of the danger of placing it out of continuity as in the operation of antral exclusion. Indeed E. R. Woodward and Tillmans believe that it is contact with acid which inhibits the antrum's production of further acid secretion. Harrison *et alii* (1956) go further and say that the antrum in continuity produces an inhibitor of gastric secretion. Wangensteen prefers segmental resection to his own formerly introduced Tubular Resection. No recurrence occurred in 90 patients followed for four years (Wangensteen, 1956). Surgeons await further reports from Wangensteen, and one of great interest has come (Wangensteen, 1958).

Segmental resection requires a "drainage" operation such as pyloroplasty because of the inevitable concomitant vagotomy. But Deloyers and his assistants "deliberately do not perform any pyloroplasty in spite of the division of the left vagus. The big trunk of the right vagus is carefully dissected and kept in place . . . A certain degree of hyper-tonia of the pylorus is a favourable reaction. It helps the antral stump to develop into an adequate reservoir and also prevents an overflow into the duodenum, as happens after classical gastrectomies (dumping syndrome)." But Deloyers mentions only "about twenty-five" such operations and admits that of these patients one had trouble resulting from the absence of pyloroplasty. Whatever Deloyers' theoretical claims, the proven very low incidence of ulcer recurrent after adequate lower gastrectomy can hardly be held to justify his more mutilating operation entailing transthoracic division of the abdominal oesophagus, and removal therefore of all the intrinsic apparatus of the cardia.

(b) Another use for oesophago-jejunostomy. Oesophago-jejunostomy has a well-known use for non-dilatable stricture complicating peptic ulcer of the oesophagus in an adult. For any oesophago-jejunostomy the Roux en-Y anastomosis is the least troublesome (Tanner, 1956). A second use for oesophago-jejunostomy has been recently found: should recurrent ulcer be so persistent as to follow both adequate resection and vagotomy, then Balint and Gummer go so far as to advise total gastrectomy. This must be a severe remedy; but the twelve patients submitted all survive, take vitamin B12 and oral iron, and those with Roux en-Y anastomoses are holding their weight, "eating normal meals and living normal lives." The work of Burge and Vane (1958) may make total gastrectomy unnecessary.

(c) Intra-cranial intervention. An attack in a region remote from the bleeding ulcer is advocated by M. Bucaille of Saint Antoine Hospital, Paris. Bucaille destroys by electrocoagulation the median ventral quadrant of the frontal lobe, the region considered to be the cortical projection zone of the hypothalamus. This work, with references to publications, was reported in correspondence to the Editor of the *Medical Journal of Australia* on 9th February, 1957, page 184. Bucaille claims that no psychic sequelae arise, and that the quadrantic coagulation is therefore not psycho-surgery but physiological surgery akin to sympathectomy or vagotomy.

But whether his intervention will be adequate often enough remains to be seen. Meantime we may note in passing that the relation

between interbrain and peptic ulcers was described by W. S. Halsted's pupil, Harvey Cushing (1932).

BILLROTH AND HIS PUPILS

Billroth was born on the island of Rügen in 1829, and thus was only three when Lembert published. Rügen is a famous and picturesque Baltic Sea holiday resort much visited for treatment in baths of Baltic Sea water. It has white chalk cliffs and green forests and is a province of Pomerania in eastern Germany now under Russian control. The island is also a ferry-boat terminal for the crossing to Sweden (Suerth, 1958). Virchow was born on the same island nine years before Billroth and according to Williams (1954) both were Protestants but Virchow's forbears came from nearby Poland while Billroth's were Swedish. Billroth was named, probably christened, Christian Albert Theodor; Theodor, gift of the gods.

Billroth graduated in Berlin at the age of twenty-three and became an assistant to Bernhard von Langenbeck, nephew of an earlier famous Langenbeck. At the age of thirty-one Billroth became professor of surgery at Zurich, where he stayed for seven years. From 1867 till his death in 1894 he was professor of surgery in Vienna.

Garrison (1929) wrote that of the surgeons of Lister's time, who developed Lister's ideas in new fields, perhaps the first place belongs to Billroth. He is especially remembered as the surgeon of the alimentary tract, indeed as the "Pioneer of Visceral Surgery."

Billroth did the first resection of the oesophagus, the first complete excision of the larynx and a large number of intestinal resections and enterorrhaphies. He was the first to introduce the staging of colectomy for cancer, a principle later developed by his pupil Mikulicz. These early operations upon the gastro-intestinal tract provided, in Moynihan's phrase, a "pathology of the living."

Billroth was a man of charming, genial personality whose artistic gifts were revealed in the verse and music which he left, and in his delightful *Briefe*, in part a memorial to his lifelong friendship with the great North German composer, Johannes Brahms (Garrison).

In the Franco-Prussian War Billroth was a military surgeon with Esmarch, uncle by marriage of the last Kaiser, introducer of the Esmarch bandage and first-aid pack (Castiglioni).

Among Billroth's pupils were three Slavs, Mikulicz, Wölfler and Czerny; a Swiss, Kocher, and an Austrian, von Eiselsberg (Garrison).

Johann von Mikulicz-Radecki

Mikulicz lived from 1850 to 1905. He came from Cernowitz, then in Poland now in U.S.S.R. According to Hughes (1957) Mikulicz learnt his pathology from Rokitansky who drew pupils to Vienna from all Europe (Castiglioni). Rokitansky incidentally described gastric ulcer-cancer in the same year as Cruveilhier (Hurst and Stewart, 1929).

Mikulicz became Billroth's assistant. In 1881 he won the chair of surgery at Königsburg (now Kaliningrad in Lithuania under Russian rule), and three years later that of Breslau, now Wroclau in Southern Poland. He was one of the first to wear gloves while operating, but his cotton gloves were soon superceded by those of rubber, introduced by W. S. Halsted (Castiglioni). These rubber gloves were obtained by Halsted to protect from disinfectant the hands of a Johns Hopkins operating room nurse, Miss Caroline Hampton. A high spirited young lady, she had been allotted to a post of special responsibility in the theatre; she became Mrs. Halsted. No authority is given, and possibly cannot be, for this story told by Williams, but to Halsted's otherwise somewhat bleak life story it adds a note almost of warmth.

Mikulicz was the first (Ogilvie, 1947), though not the first successfully (Ogilvie, 1947; Lawson, 1958), to suture a perforated gastric ulcer. He advanced partial gastrectomy and colectomy and took Billroth's oesophagectomy to its logical conclusion by combining it with plastic replacement. Nine years before Röntgen's discovery of X-rays when therefore there could be no alternative but the patient's death, Mikulicz introduced

lateral pharyngotomy for the excision of malignant tumours of the tonsil. He described symmetrical enlargement of the lacrimal and salivary glands, Mikulicz's disease.

Kocher made it plain that he regarded Mikulicz as a great abdominal surgeon. J. M. T. Finney, who visited Europe in 1894, brought back from Germany unhappy memories of its surgery; "von Mikulicz, at Breslau, alone struck him more favourably. He found much interest in the clinics of Bassini at Padua, Kocher at Berne, and Billroth in Vienna, though Billroth himself had died earlier in the year" (Power and Le Fanu).

Mikulicz was invited to Rochester, where he demonstrated gastric surgery to William Mayo (Clapesattle, 1941).

The anecdotes which follow come from Sauerbruch's translated autobiography. The style of writing there is somewhat flamboyant and perhaps incautious. Nevertheless, Sauerbruch plainly revered Mikulicz and there seems no reason to disbelieve what he says of him. Mikulicz stimulated his interest in intrathoracic surgery, but soon, according to Sauerbruch, rebuked him as a charlatan and banished him from the Breslau clinic because Sauerbruch failed in an intrathoracic experiment, thus killing a dog.

Later he took Sauerbruch back and introduced this pioneer of thoracic surgery to a Berlin Surgical Congress by assisting him there at a thoracotomy.

After his return from Minnesota, shortly before his twenty-fourth wedding anniversary, Mikulicz became convinced that he had an abdominal cancer. As time would be short he forthwith arranged a private occasion. For long he had intended to give his wife a gold watch in order to replace one which she had lost early in their marriage. For the presentation he asked Sauerbruch to arrange an extravagant setting, and when all had dined Mikulicz said to his wife: "Today we are celebrating our silver wedding anniversary." His wife protested that there was a year to wait, but Mikulicz insisted that this was the twenty-fifth anniversary and presented the gold watch.

Soon another Billroth pupil, von Eiselsberg, was summoned to Breslau from Vienna. Sauerbruch wrote that he himself gave the anaesthetic while von Eiselsberg opened Mikulicz's peritoneum and found non-resectable cancer.

Of an incident in the after-period, Sauerbruch wrote that Mikulicz led him over to a microscope put a slide under it, and asked for an opinion. Sauerbruch said that he thought that this was cancerous tissue. Mikulicz pressed his hand and said: "von Eiselsberg is trying to make me believe that my tumour is not malignant. A doctor should always tell the truth . . . the patient is entitled to know the truth."

By the time of the twenty-fifth anniversary Mikulicz was dead.

Anton Wölfler

Anton Wölfler, like Mikulicz, was born in 1850. Like Czerny, he came from Bohemia. Like both, he became a professor of surgery in two cities, his first being Graz and second Prague.

He was specially interested in the surgical treatment of goitre. While Mikulicz was describing the first three Billroth I operations at a German Surgical Congress, Wölfler was performing the fourth successfully in Billroth's clinic in Vienna (Gordon-Taylor *et alii*). Wölfler not only introduced gastroenterostomy but was also, in 1894, the first to perform gastro-gastrostomy for hour-glass stricture (Robson and Moynihan). He died during the first World War aged 67 (Garrison).

Vincenz Czerny

Czerny extended Billroth's work on the excision of the larynx and the oesophagus. He was one of the earliest users of partial gastrectomy for ulcer (Robson and Moynihan) and the first to describe post-operative gastrojejuno-colic fistula (Hurst and Stewart). He founded the Institute for Experimental Cancer Research at Heidelberg (Castiglioni), the *Samariterhaus* being opened under his direction in 1906 (Garrison). Czerny died ten years later aged 74.

Theodor Kocher

Kocher was born in Bern, Switzerland, in 1841. He was appointed professor of surgery in his native town in 1872 and held the

chair there until his death in 1917. Kocher was a careful, precise and slow operator, a typical scientific surgeon who got from his patients a complete history before beginning treatment and with whom success was an almost foregone conclusion. He insisted on a totally aseptic operation and was a master of minute dissecting. Fuller comment and a portrait are to be found in Garrison who contrasts Kocher and his pupil César Roux, later of Lausanne. Roux's post-haste, sleight-of-hand methods were more like the dramatic, cinematographic operating of the Parisian Doyen than the careful operating of Lister, Halsted and Kocher himself. Kocher introduced latero-terminal gastro-duodenostomy which produces no corners of tissue cut off on two sides from their blood supply, thus eliminating the danger angle from the original Billroth I; he improved the reduction of dislocated shoulders, first excised the thyroid for goitre, and did over 2,000 thyroidectomies with a mortality in those early days of 4.5 per cent. Some of the earliest patients postoperatively developed "cachexia strumipriva," the reporting of which in 1883 inaugurated the surgical physiology of the endocrines (Garrison).

Anton Freiherr von Eiselsberg

Von Eiselsberg was born in 1860 and in the *Lives of the Fellows of the Royal College of Surgeons of England* it is said that he was a somewhat delicate child who passed through the seven years' course at the Gymnasium without special distinction. The training was wide and thorough and as a result he kept throughout his life an interest in comparative anatomy, the classics, and religion. Wölfler brought him to the notice of Billroth of whom he became favourite pupil and personal assistant. His innovations in gastric surgery have been mentioned. and he trained von Haberer (Orator, 1928).

At the age of thirty-three he was appointed professor of surgery at Utrecht. though a Roman Catholic. After holding the same appointment at Königsburg he returned in 1901 to Vienna as professor. He was one of the first to note tetany after goitre operations and to transplant the parathyroids. Later he became a prominent worker in pituitary surgery.

Von Eiselsberg came from a military family and, to quote Power and Le Fanu, "had all the charm and the manner of a cultivated Austrian gentleman. A great traveller to observe the advances of surgery, and a good sportsman, he was equally welcome in England, Scotland, the United States, and France. His last years were saddened by the annexation of Austria, and by the consequent decadence of the great Viennese school of medicine, which he had seen at its zenith. He had for many years the chief surgical practice in the east of Europe and in May, 1915, he was called to Athens to operate upon King Constantine, who was then suffering from an empyema." Von Eiselsberg died on 25th October, 1939, as the result of a railway accident caused by sabotage (Power and Le Fanu).

STATUS OF CURRENT PROCEDURES

In a woman (Illingworth), in a man over fifty (Clark), particularly if obstructing (Walters, 1956), or for "drainage" with vagotomy (Burge and Pick), gastro-jejunostomy for duodenal ulcer retains a useful role. Heinecke-Mikulicz pyloroplasty may very occasionally be used for closure after opening antrum and duodenum to find suspected bleeding pre-pyloric, pyloric or duodenal ulceration (Walters, 1956). Finney's gastro-duodenostomy is sometimes used as a "drainage" operation for vagotomy or is, infrequently, expedient for preventing stenosis when suturing a pyloric perforation (Tanner, 1955); the use of Finney's principle in urology and thoracic surgery has been mentioned. Vagotomy may yet find a place with short-circuiting as above, and is accepted for ulcer recurrent after adequate gastric resection (Ogilvie, 1947; Walters, 1955). Billroth's extended first and his modified second gastric resections, despite a proportion of undesirable sequelae (Visick, 1948; Thomson, 1957b) survive today as world-wide elective operations for gastric ulcer, stomal ulcer, and for duodenal ulcer complicated by repeated bleeding, repeated perforation, stenosis or unmanageable pain (Ogilvie, 1947; Illingworth, 1953: Odelberg, 1954; Walters, 1956; Thomson, 1957a). Peptic ulcers occur only in relation to normally sited or ectopic gastric epithelium: Billroth and his pupils worked out gastric resection about three-quarters of a century ago not for ulcer but for cancer; of all the operations since devised however, lower gastric resection alone diminishes the gastric epithelium at the same time removing the antrum which excites it.

SUMMARY

1. An outline is given of some of the extremely heterogeneous operations that have been applied to the treatment of peptic ulcers.
2. Special notice is taken of contributions by Billroth and his pupils, about whose lives brief notes are added.
3. Incidental mention is made of the earlier history of intestinal suture.
4. The fate of the operations is briefly shown.

REFERENCES

ALLEN, A. W. (1947), *Ann. roy. Coll. Surg. Engl.*, vol. 1, page 235.

AYLETT, S. (1951), *Brit. med. J.*, vol. 1, page 445.

—— (1953), *Lancet*, vol. 2, page 297.

—— (1954), *Lancet*, vol. 2, page 1180.

BALFOUR, D. C. (1914), *Surg. Gynec. Obstet.*, vol. 19, page 528.

—— (1935), *Aust. N.Z.J. Surg.*, vol. 5, page 101.

BALINT, J. A. and GUMMER, J. W. P. (1958), *Lancet*, vol. 2, page 1044.

BERG, A. A. (1925), *Surg. Clin. N. Amer.*, vol. 5, page 49.

BURGE, H. and PICK, E. J. (1958), *Brit. med. J.*, vol. 1, page 613.

CAPPER, W. M. and WELBOURN, R. B. (1954), *Lancet*, vol. 2, page 193.

CARSON, H. W. (1924), "Modern Operative Surgery." Lond, Cassell & Company.

CASTIGLIONI, A. (1941), "A History of Medicine," translated by E. B. Krumbhaar. New York, Alfred A. Knopf.

CLAPESATTLE, H. (1941), "The Doctors Mayo." New York, Garden City Publishing Co. Inc.

CLARK, D. H. (1951), *Brit. med. J.*, vol. 1, page 57.

CONNELL, F. G. (1938), *Surgery*, vol. 3, page 696.

Correspondence (1957) to Editor, *Med J. Aust.*, 1, 184.

CUSHING, H. (1932), *Surg. Gynec. Obstet.*, vol. 55, page 1.

DELOYERS, L. (1956), *Ann, roy. Coll. Surg. Engl.*, vol. 18, page 277.

DEVINE, Sir Hugh B. (1940), "The Surgery of the Alimentary Tract." Bristol, John Wright & Sons.

DOYLE, L. (1951), *Aust. N.Z.J. Surg.*, vol. 20, page 245.

DRAGSTEDT, L. R. (1945), *Ann. Surg.*, vol. 122, page 973.

EDKINS, J. S. (1906), *J. Physiol.*, vol. 34, page 133.

EDWARDS, H. C. (1948), "Recent Advances in Surgery," 3rd Edition. London, J. & A. Churchill Ltd.

Eulogy (1952) on life of John Miller Turpin Finney (1862-1942), *Ann. Surg.*, vol. 135, page 577.

GARRISON, F. G. (1929), "An Introduction to the History of Medicine," 4th Edition. Philadelphia and London, W. B. Saunders Company.

—— and MORTON, L. T. (1954), "Medical Bibliography," 2nd Edition. London, Grafton & Co.

GORDON-TAYLOR, G., HUDSON, R. V., DODDS, E. C., WARNER, J. L. and WHITBY, L. E. H. (1929), *Brit. J. Surg.*, vol. 16, page 641.

HANLEY, H. G. (1957), "Recent Advances in Urology." London, J. & A. Churchill.

HARKINS, H. N. (1954), *Ann. Surg.*, vol. 140, page 405.

HARRISON, R. C., LAKEY, W. H. and HYDE, H. A. (1956), *Ann. Surg.*, vol. 144, page 441.

HENLEY, F. A. (1953), *Ann. roy. Coll. Surg. Engl.*, vol. 13, page 141.

HERTZ, A. F. (later Sir A. F. Hurst) (1913), *Proc. roy. Soc. Med.*, vol. 6, page 156.

HEY, Wilson H. (1947), *Brit. Med. J.*, vol. 2, page 395.

HORSLEY, J. S. (1930), *Ann. Surg.*, vol. 92, page 545.

HUGHES, E. S. R. (1957), "Surgery of the Anus, Anal Canal and Rectum." Edinburgh, E. & S. Livingstone.

HURST, Sir A. F. and STEWART, M. J. (1929), "Gastric and Duodenal Ulcer." London, Oxford University Press.

ILLINGWORTH, C. F. W. (1953), "Peptic Ulcer." Edinburgh, E. & S. Livingstone.

JUDD, E. S. and RANKIN, F. W. (1923), *Coll. Papers Mayo Clin.*, vol. 15, page 107.

KAY, D. W. (1956), *J. roy. Coll. Surg. Edin.*, vol. 2, page 54.

KINSELLA, V. J. (1956), *Brit. med. J.*, vol. 2, page 1278.

KOCHER, T. (1911), "Operative Surgery," 3rd English Edition. London, A. & C. Black. Authorised translation from 5th German Edition by H. J. Stiles, pages 565 and 597.

LAHEY, F. H. (1942), "Surgical Practice of the Lahey Clinic." Philadelphia, W. B. Saunders.

LAWSON, R. (1958), "The First Successful Operation for Perforated Peptic Ulcer." Paper read to Section of History of Medicine, Australasian Medical Congress (B.M.A.), Hobart.

MCKITTRICK, L. S., MOORE, F. D. and WARREN, R. (1944), *Ann. Surg.*, vol. 120, page 531.

MAYO, W. J. (1910), *Ann. Surg.*, vol. 52, page 797.

MOLONEY, G. E. (1954), *Brit. med. J.*, vol. 1, page 1186.

MORONEY, J. (1953), *Ann. roy. Coll. Surg. Engl.*, vol. 12, page 328.

MORTON, C. B., ALDRICH, E. M. and HILL, L. D. (1955), *Ann. Surg.*, vol. 141, page 759.

MOYNIHAN, B. G. A. (1920), *Brit. Med. J.*, vol. 2, page 33.

—— (1926), "Abdominal Operations." London, W. B. Saunders Company, vol. 1, pages 255-258.

Obituary of Eugen (Jeno) Alexander Polya, 1876-1944 (1946), *Med. J. Aust.*, vol. 1, page 823 (by H. C. Rutherford Darling)

—— (1946), *J. Internat. Coll. Surg.*, vol. 9, page 737.

ODELBERG. A. (1954), *Lancet*, vol. 2, page 332.

OGILVIE, Sir W. H. (1928), "Recent Advances in Surgery." London, J. & A. Churchill, page 275.

—— (1947), *Ann. roy. Coll. Surg. Engl.*, vol. 1, page 37.

—— (1952), *Lancet*, vol. 1, page 1077.

—— (1953), *Lancet*, vol. 1, page 555.

—— (1953), *Lancet*, vol. 2, page 203.

—— (1954), *Lancet*, vol. 2, page 1231.

ORATOR, V. (1928), *Surg. Gynec. Obstet.*, vol. 47, page 368.

ORR, I. M. and JOHNSON, H. D. (1947), *Lancet*, vol. 2, page 84.

POWER, Sir D'Arcy (1927), *Brit. J. Surg.*, vol. 14, page 385.

—— and LE FANU, W. R. (1953), "Lives of the Fellows of the Royal College of Surgeons of England, 1930-1951." London, Royal College of Surgeons.

PRIBRAM, B. O. (1924), cited by O. J. Oschner, Editor of "General Surgery" in the Practical Medicine Series. Chicago, The Year Book Publishers, page 337.

QUIST, G. (1958), *Brit. J. Surg.*, vol. 45, page 341.

ROBSON, A. W. M. and MOYNIHAN, B. G. A. (1901), "Diseases of the Stomach and their Surgical Treatment." London, Baillière Tindall & Cox, pages 264 and 278.

ROWLANDS, R. P. and TURNER, P. (1927), "The Operations of Surgery." London, J. & A. Churchill, page 130

SAUERBRUCH, F. (1953), "A Surgeon's Life." London, Deutsch.

SHERRIN, J. (1922), in "An Index of Prognosis and End-results of Treatment" (Editor, A. Rendle Short). Bristol, John Wright & Sons Ltd.

SOMERVELL, T. H. (1945), *Brit. J. Surg.*, vol. 33, page 146.

STAMMERS, F. A. R. (1954), *Brit. J. Surg.*, vol. 42, page 34.

STEWART, G. D. and BARBER, W. H. (1916), *Ann. Surg.*, vol. 64, page 526.

SUERTH, E. (1958), personal communication.

SUTTON, Sir J. Bland (1916), *Lancet*, vol. 1, page 387.

TANNER, N. C. (1950), *Postgrad. Med. J.*, vol. 25, page 575.

—— (1951), *Edin. med. J., vol.* 58, page 261.

—— (1955), in "Modern Operative Surgery," 4th Edition. London, Cassell & Co., vol. 1, page 796.

—— (1956), in "Medical Annual," 74th Issue. Bristol, John Wright & Sons Ltd.

—— (1957), in "Medical Annual," 75th Issue. Bristol, John Wright & Sons Ltd.

THOMSON, E. (1957a), *Med. J. Aust.*, vol. 1, page 306.

—— (1957b), *Med. J. Aust.*, vol. 1, page 333.

THOREK, M. (1938), "Modern Surgical Technic." Philadelphia, J. B. Lippincott Company.

VISICK, A. H. (1948), *Ann. roy. Coll. Surg. Engl.*, vol. 3, page 266.

WALKER, R. M. and HAXTON, H. (1954), *Brit. J. Surg.*, vol. 42, page 26.

WALLENSTEIN, S. (1955), *Surgery*, vol. 38, page 289.

WALTERS, W. (1949), "Operative Technic in General Surgery." New York, Appleton-Century-Crofts Inc. (W. H. Cole, Editor.) Pages 372, 386, 387, 414.

—— (1956) in "Christopher's Textbook of Surgery," 6th Edition. Philadelphia and London, W. B. Saunders Company, page 606.

——, CHANCE, D. P. and BERKSON, J. (1955), *Surg. Gynec. Obstet.*, vol. 100, page 1.

WALTON, Sir A. J. (1923), "A Textbook of the Surgical Dyspepsias." London, E. Arnold.

WANGENSTEEN, O. (1956), *Ann. Surg.*, vol. 144, page 441.

—— (1958), *Postgrad. Med.*, vol. 23, page 466.

WILLIAMS, H. (1954), "Masters of Medicine." London, Pan Books, pages 155 and 160.

WOODWARD, E. R. and TILLMANS, V. C. (1955), "Surgical Forum." Philadelphia, W. B. Saunders Company.

Additional references of interest not referred to in the text:

BARBER, W. H. (1917), *Ann. Surg.*, vol. 66, page 672.

DEVINE, H. B. (1928), *Surg. Gynec. Obstet.*, vol. 47, page 239.

—— (1935), *Aust. N.Z.J. Surg.*, vol. 5, page 112.

FINSTERER, H. (1909), *Surg. Gynec. Obstet.*, vol. 31, page 52.

—— (1926), *Brit. med. J.*, vol. 2, page 557.

JUDD, E. S. and HAZELTINE, M. E. (1930), *Ann. Surg.*, vol. 92, page 563.

ROBSON, Sir A. W. Mayo (1912), *Brit. med. J.*, vol. 1, page 1.

VON EISELSBERG, A. F. (1914), *Surg. Gynec. Obstet.*, vol. 19, page 555.

References to foreign original documents may be had from WALTON (1923), GORDON-TAYLOR *et alii* (1929), WALTERS (1949), ILLINGWORTH (1953), GARRISON *and* MORTON (1954), WANGENSTEEN (1958).

SOME RECENT STUDIES ON THE PHYSIOLOGY OF SMOOTH MUSCLE, AND THE MECHANICAL ASPECTS OF GASTRO-INTESTINAL FUNCTION, AND SOME POSSIBLE IMPLICATIONS TO SURGICAL PROBLEMS

By G. W. Milton

Department of Surgery, University of Sydney

THE object of the present paper is to review the recent work in the physiology of gastro-intestinal smooth muscle and to attempt to relate the findings of the laboratory to clinical practice. The paper is divided into two parts: (A) A review of the recent literature on the physiology of gastro-intestinal smooth muscle and the mechanism of gastric emptying; (B) Some possible implications of this work to gastro-intestinal surgery.

(A) Investigators who wish to study the physiology of gastro-intestinal smooth muscle usually take one of two paths. Those who have clinical applications of their work in mind design their experiments so as to disturb the normal relationships of the tissues as little as possible. The "pure" physiologist, however, by using increasingly intricate apparatus studies the gut *in vitro*, either as a whole or as the smallest single unit, the smooth muscle cell.

Berkson *et alii* (1932, 1933) and Puestow (1933), studied the electrical waves which may be recorded from the gut *in vivo*, Bozler (1938, 1939, 1946) and Ambache (1947), in similar studies used isolated pieces of gut *in vitro*. These workers recorded two types of electrical change from the gut wall. The first is a slowly changing electropotential wave which does not appear to be directly related to the contractions in the bowel wall, although Bozler (1941) differed from the other investigators on this point. The second type of electrical wave in the gut is a series of rapid spikes and all workers agreed that with surface electrodes the size and number of these spikes was roughly proportional to the amount of contraction in the bowel wall.

The electropotential changes recorded from dog intestine, in continuity, and in the conscious or anaesthetized animal was studied by Milton, Smith and Armstrong (1955), Armstrong, Milton and Smith (1956), and Milton and Smith (1956). The findings of the earlier workers were largely confirmed as two separate electropotential waves were seen (Fig. I). The bursts of rapid spike deflections (Fig. I, a) occur only when the gut is contracting, the size and number of the spikes being roughly proportionate to the amount of movement in the gut. If the animal was given an injection of prostigmine, which increases the force of intestinal contraction, then the size of the bursts of spikes increase (Fig. II). The spikes could be completely eliminated by injecting any drug, such as atropine, which eliminates intestinal contraction (Fig. I). It will be noticed that the bursts of spikes follow the slow wave (Figs. I and II). The size of the slow wave is not influenced by the size of the muscle spikes nor by the presence or absence of movement in the gut. The slow electropotential wave was recorded from the small intestine continuously whether the animal was fasting or feeding, conscious or anaesthetized. As the slow wave is not affected by the presence or absence of movement in the gut wall it seems unlikely that it takes a direct part in the contractile process. However, the muscle spikes when they occur always follow the slow wave so that although the tissue which gives rise to the slow wave does not actively contract itself it seems to be responsible for "triggering off" the muscle. In other words the slow electropotential wave in the gut wall appears to be concerned with the stimulation of the muscle fibres to contract, and the co-ordination of the muscle fibres one with another when they do contract. If this is so, then the slow electropotential wave should occur at different frequencies at different levels of the small intestine, because the frequency of contractions of the duodenum is greater than the terminal ileum (Alvarez, 1914; Legros and Onisums, 1869). In dogs the frequency of

contractions of the duodenum and upper jejunum is 18 per min., and of the terminal ileum 12 per min. (Douglas and Mann, 1939; Douglas, 1948). If the slow wave does in fact co-ordinate intestinal contraction then the frequency of the slow wave in dog intestine should be the same as the frequency of contractions, and we have found this to be so (1956). Again, if the slow electropotential wave is the stimulator and co-ordinator of the intestine then the linear velocity along the gut must also agree with the observed velocity of peristalsis. Douglas (1948) found the linear velocity of peristalsis in the dog duodenum was approximately 12 cms/sec., and Bayliss and Starling (1899) described the velocity of peristalsis in jejunum as 2 cms/sec. The velocity of peristalsis therefore becomes slower with increasing distance from the duodenum. The velocity of the slow electropotential wave in the duodenum varies between 10-30 cms/sec., and in the jejunum 3-5 cms/sec., and in one experiment we found the velocity to be even slower in the terminal ileum, i.e., 0.5 cms/sec.

Douglas (1948) never saw antiperistalsis in the dog duodenum, and the slow electropotential wave also was never seen by us to travel in an antiperistaltic direction in the duodenum. In the upper jejunum, however, if the slow wave was recorded simultaneously from two points about 6 cms. apart, it was often found that the rhythm at one point was slightly different from that of the other. In other words if the gut should contract then a segmental type of movement results and not a peristaltic wave. The terminal ileum shows this independence of adjacent segments even more frequently than the jejunum. Segmental types of movements are more commonly seen in the jejunum than in duodenum, and more commonly in the ileum than in either of the other parts of the small bowel. There do not appear to be any types of electrical change in the gut which are pathognomonic of a segmental type of movement. Segmental and peristaltic movements can only be distinguished electrically by recording simultaneously from several adjacent points on the bowel surface. As the duodenum and

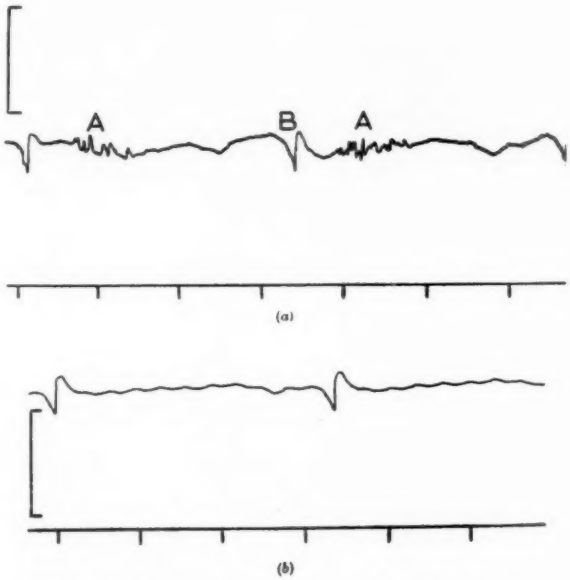

FIG. I. Electrical activity recorded from the wall of the duodenum in the dog. The upper trace shows the rapid spike deflections (A) which follow immediately after the longer slow electropotential wave (B). The lower trace was obtained following the injection of 8 mgm. Banthine. Note the disappearance of the spikes following the injection which eliminated recordable movement from the duodenum. Time secs. Calibration 0.6 mV.

jejunum are so intimately related to one or other type of gastrectomy these marked differences in function have some implications in this operation.

divided at the middle of the loop and reunited by end to end anastomosis, and it was found (1956) that the frequency of the slow wave recorded distal to the anastomosis remained less than that recorded proximal to the anastomosis for up to eight months after operation (unpublished). In other words once the conduction is destroyed it does not become re-established, at least for a considerable time. The muscle spikes when they occurred followed the slow wave at the decreased frequency distal to the anastomosis (Fig. IV) and the frequency of the recorded contractions was also less distal to the anastomosis. Therefore once the duodenum is divided the conduction of the slow electropotential wave along it does not become re-established, and the frequency of the slow wave distal to the anastomosis remains decreased. The frequency of the muscle spikes and of the contractions of the bowel wall are also decreased and to the same extent. The slow wave therefore does appear to be the factor which governs the frequency of intestinal contraction and also co-ordinates the smooth muscle of the bowel wall, so that when it does contract it does so in an orderly fashion and not haphazardly.

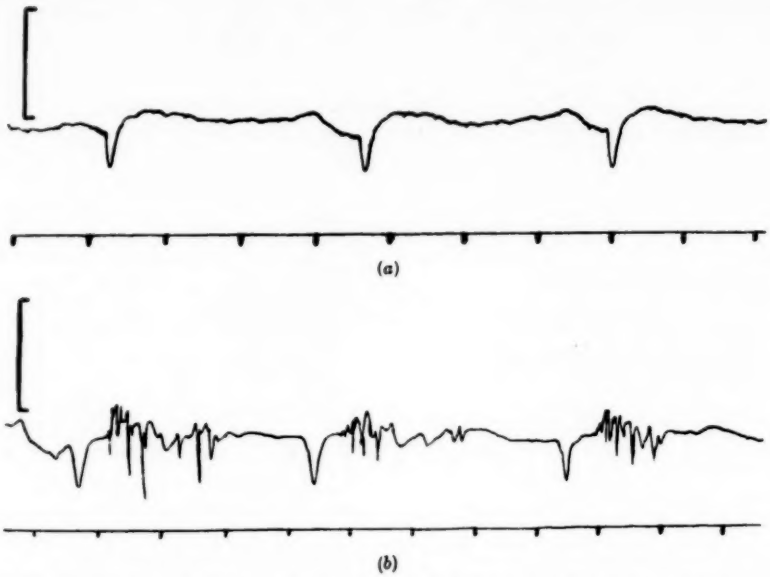

FIG. II. The upper trace shows the record obtained during a period of quiescence in the duodenum—no visible movement present. The lower trace was obtained five minutes after 0.2 mgm neostigmine had been administered. The duodenum was actively contracting and the slow wave was followed by a long burst of fast potentials. Time, secs. Calibration 0.8 mV.

If the slow electropotential wave in the small bowel is responsible for the co-ordination of the muscle in the wall, then, if the frequency of the slow wave could be changed the frequency of contraction should change to the same extent. We (1956) have found that this does in fact occur. It has been shown (1955) that the frequency of the slow wave recorded from the exteriorized duodenum is identical at each end of the loop (Fig. III). When a spring bladed intestinal clamp was applied across the loop between the electrodes the frequency of the slow wave distal to the clamp immediately decreased (Fig. III). This effect is presumably due to the blockage of the conduction of impulses along the bowel wall due to the combined effect of pressure and ischaemia. Causey and Palmer (1949) showed a similar effect of pressure on the conduction in peripheral nerves and Stannius (1852) and Gaskell (1882) had blocked the conducting mechanism in the heart by pressure. In four animals the duodenum was

As the effect of clamping or dividing the duodenum was to decrease the frequency of the slow wave distal to the site of the clamp or division it follows that there must be some mechanism proximal to the mid-point of the duodenum which maintains the frequency of the slow wave in the distal duodenum (Milton and Smith, 1956). The frequency of the slow wave in the exteriorized duodenum was not affected by clamping or dividing the pylorus, or duodenum, proximal to the entrance of the bile duct. But if the duodenum distal to the entrance of the bile duct was clamped, divided, or infiltrated with procaine then the frequency of the slow wave in the distal duodenum and the proximal 50 cms. of jejunum

The tissue in the intestinal wall from which the slow electrical wave originates has not been finally determined. Earlier workers such as Berkson *et alii*, and Puestow (1933) believed that it probably originated from the nerve plexuses in the gut wall. Bozler (1938, 1939, 1946) pointed out that the nerve plexuses are very small to produce so large an electrical wave. It has also been shown that co-ordinated contractions can occur in smooth muscle which is free of all ganglion cells (Evans and Schild, 1953 a, b; Prosser, Sperelakis and Bergman, 1955; Kockinsky, Lullman and Muscholl, 1954; Bülbring, Burnstock and Holman, 1957). These observations suggest that the nerve plexuses in the bowel wall

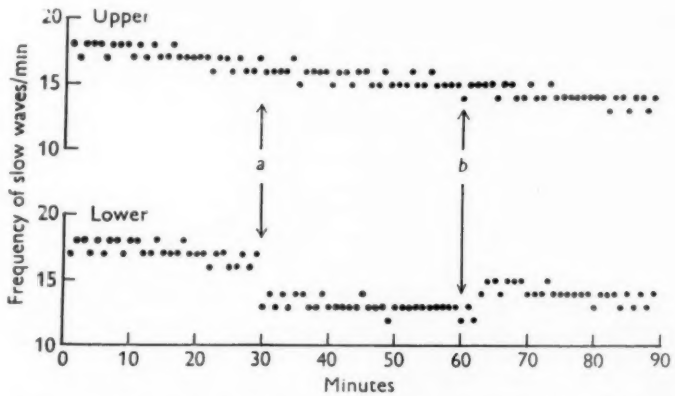

FIG. III. The effect on the frequency of the slow electropotential waves of clamping the duodenum between two pairs of recording electrodes. Upper graph, upper electrode. Lower graph, lower electrode. (a) clamp on, (b) clamp off. Note the decrease in frequency of the slow electropotential wave below the clamp.

immediately decreased. These findings suggest that there exists in the duodenum at the region of the entrance of the bile duct a pacemaking area which is responsible for maintaining the frequency of the slow electropotential wave, and consequently the frequency of intestinal contractions of the remainder of the duodenum and upper jejunum. It is perhaps of interest that in 1915 Sir Arthur Keith postulated the existence of three pacemaking regions in the small bowel, the first in the duodenum near the ampulla of Vater, the second at the ligament of Treitz, and the third at the ileocaecal valve. However, although there was some evidence for the existence of a second pacemaking region, we (1956) did not find any evidence for the third.

are not essential for co-ordination of the smooth muscle, at any rate over short lengths up to 2 cms. The co-ordination is probably accomplished by conduction of an electropotential wave from one muscle cell to the next as Bozler (1948) and Prosser, Sperelakis and Bergman (1955, 1956) suggest.

However, the nerve plexuses may have a more important part to play in co-ordinating the motility of the bowel at junctional areas such as the cardia, pylorus, or ileocaecal valve.

It seems on present evidence that for most of the small intestine the co-ordination of movement is accomplished by the slow electropotential wave. Bülbring (Bülbring and Hooton, 1953; Bülbring, 1954, 1957) showed that

there is a slowly fluctuating membrane potential at the surface of smooth muscle cells, in addition to bursts of rapid spike deflections. The frequency of the spike deflections is roughly proportional to the strength of contraction of the muscle strip which she used (Bülbring, 1955). The number of the spikes is influenced by the level of the fluctuating membrane potential; if the membrane potential falls then the number of the spikes increases and *vice versa*. It appears likely that the fluctuating membrane potential spreads from cell to cell and in this way co-ordinates the contractions of the bowel.

in the dog small intestine decreases from 18/min. to 12-13/min. over the same distance. In the dog antiperistalsis in the duodenum is rare (Douglas, 1948), but in man movement of barium in the duodenum often appears to be antiperistaltic; whether this is true antiperistalsis or simply a localized contraction forcing fluid into a relaxed piece of duodenum has been debated (Salmond, 1928; Inglefinger and Moss, 1942; Wheelon, 1923, a, b; Morin and Monges, 1951; Boulton and Goodhart, 1922; Boulton and Salmond, 1927; Shanks *et alii*, 1950; Schinz *et alii*, 1954; McLaren *et alii*, 1950-51; Templeton, 1944).

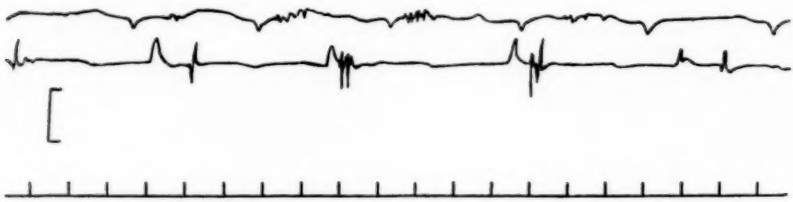

FIG. IV. Electrical record obtained simultaneously from positions above (upper trace) and below (lower trace) the site of division and anastomosis of an exteriorized duodenal loop. Note 1. The decreased frequency of the slow electropotential wave below the anastomosis. 2. The rapid spike deflections follow the slow wave at both the normal and decreased frequency. Time sec., Calibration 1.8 mV, upper trace, 1.4 mV, lower trace.

The foregoing experiments were carried out in dogs and guinea pigs and it is therefore worthwhile considering to what extent one may apply the results of experiments which cannot be repeated in man to the problems of human surgery. Although the anatomy of the stomach, duodenum and small intestine of the dog are very similar to man it does not follow that functionally they are equally similar.

The finding that the linear velocity of peristalsis in dogs decreases from the duodenum to ileum is to some extent confirmed in another animal (rat) by Reynell and Spray (1956) who showed that the rate of transport of gut content decreased towards the ileum. The passage of a barium meal also suggests that this slowing down occurs in the distal small intestine of man. There is also a gradient in the frequency of the contractions of the small intestine of man as well as in other animals. In man the frequency of the basic rhythmic contraction decreases from 11/min. to 8/min. from the duodenum and upper jejunum to the terminal ileum (Foulk *et alii*, 1954; Code *et alii*, 1957), contraction

It seems therefore valid to assume: (1) that the duodenum and small bowel of man has a conducting mechanism similar to other animals, and that this is probably a property of the smooth muscle cell membrane, and not of the nerve plexus; (2) that conduction is more rapid in the duodenum and upper jejunum than in the ileum; (3) that conduction along the bowel may be blocked by the ischaemia produced by a spring bladed intestinal clamp, and that the block may be permanent; (4) that the conducting mechanism does not regenerate across an anastomosis; (5) that the conducting mechanism is predominantly aboral at all levels, being especially so in the duodenum and upper jejunum.

The precise functions of the nerve plexuses in the bowel wall is difficult to determine because of the difficulty of isolating the nerve net plexuses from their related structures. It is probable that the nerve plexuses are concerned with over all motility of the bowel rather than co-ordination of one muscle fibre with another. Swenson's (1948, 1949, 1950) findings in megacolon indicate that the nerve plexuses have an important role in the

mechanics of the bowel. The nerve plexuses may also play a part in the co-ordination of junctional regions in the gut, such as the cardia. In addition to these functions there must be a mechanism which integrates the vascular supply and mechanical and secretory functions in the bowel wall, and the nerve net works are well sited for such duty.

Before considering the possible implications of this work to clinical surgery it is necessary to follow briefly one other line of physiological study, namely, the mechanism of gastric emptying. In 1904 Cannon postulated the "law of the pylorus". This "law" stated that the emptying of the stomach was largely governed by the activity of the pyloric sphincter. The sphincter was opened by the presence of acid in the pyloric antrum and this permitted chyme to pass into the duodenum. As soon as the acid chyme came into contact with the duodenal mucosa the pylorus was reflexly shut, preventing any further exit from the stomach; this alternate opening and closing of the pylorus regulated gastric emptying. However, Cannon's law has had to be modified. Although Pannett (1921) showed that in the cat after pylorplasty the initial emptying of the stomach was more rapid than normal, most investigators found that the total evacuation time was not greatly affected in animals by excising the pylorus or by splinting it open (Thomson, 1932; Medoff *et alii*, 1941; Crider and Thomas, 1937, Von Mering, 1897). Similar findings were obtained in man (Gaithner, 1928). The pyloric sphincter is therefore not the only, nor possibly even the most important part, of the mechanism that controls gastric emptying. Meschan and Quigley (1938) showed that the pyloric antrum, the pyloric sphincter, and the duodenal cap, function as one unit, and that any factor which affects one will affect all three regions. Peristaltic waves originate in the stomach in the region of the incisura angularis and spread towards the antrum and the pylorus. As these contractions near the pyloric sphincter, the sphincter itself begins to contract, and the force of the antral contraction drives the chyme out of the stomach against the combined resistance of the narrowing pylorus and the duodenal pressure. The sphincter rarely contracts sufficiently to prevent the discharge of chyme if the antral waves are strong (Quigley and Read, 1942; Brody and Quigley, 1944). The pyloric sphincter does not act independently of the pyloric antrum but as an integral part of it. This agrees with the suggestion that the gut musculature is co-ordinated by electropotential waves spreading from cell to cell. The chyme leaves the stomach as a jet and the force required for this is generated by the pyloric antrum. The pressure in a balloon in the antrum usually reaches 15-30 cms of mercury. The pressure in a balloon in the body of the stomach is much lower, usually less than 10 cms of mercury. It is of interest that although Quigley and his coworkers quite recently showed this difference in the pressures that may be developed on a balloon in different parts of the stomach the pressure differences had already been found about the end of last century. Von Ppungen (1887) showed that the pressure developed in the antrum is many times higher than the pressure on a balloon in the body or fundus. All of these findings were obtained by intragastric balloons and consequently show the strength of gastric contraction on such an object, and do not necessarily show the pressures that occur on the normal gastric contents during evacuation (Quigley and Brody, 1950). As soon as the duodenal cap is filled, it too begins to contract (Werle *et alii*, 1941); regurgitation into the stomach is largely prevented by the antral pressure and the resistance of the pylorus (Quigley, 1941; Wheelon and Thomas, 1922). Overloading of the duodenum is prevented by the dampening effect of chyme, especially the contained fatty acids, hydrochloric acid and hypertonic solutions in the duodenum, which liberate the hormone enterogastrone which decreases the force of antral contractions (Quigley, 1941; Quigley *et alii*, 1942). The depression of activity does not depend on extrinsic nerves (Quigley *et alii*, 1934). The key region for the control of gastric emptying is therefore the pyloric antrum, which is the only part of the stomach capable of generating enough force to eject the gastric contents, and inactivity of this region delays gastric emptying.

(B) Any adequate gastric resection must remove the normal mechanism for the control of gastric emptying, and restoration of the alimentary canal by the Billroth I technique does not restore the normal mechanism. As the conducting and co-ordinating mechanism of the bowel cannot bridge a scar the stomach remnant and the duodenum or jejunum continue to function independently, whichever

method of restoration is used. As a result of this the gastrointestinal canal has to develop new mechanisms, or at least adapt its own inherent properties, for the control of the flow of gastric content into the small intestine after gastrectomy. As far as the patient is concerned this adaptation is remarkably successful because only a minority of people develop serious permanent sequelae to partial gastrectomy. Hertz (1913) first suggested that the dumping of gastric contents into the upper small intestine might cause unpleasant symptoms. Since that time several papers have appeared, which showed that whatever the cause of the dumping syndrome the symptoms were most likely to be severe when gastric empting was very rapid (Smith *et alii*, 1953; Goligher and Riley, 1952; Pulvertaft, 1953 and 1954). Pulvertaft (1953) showed that the consistency of the gastric contents influenced the rate of gastric emptying, liquids passing out of the stomach more rapidly than solids. Cannon (1898) had previously shown that the emptying of the normal stomach was delayed if the contents were solid or semi-solid. Most investigators agree that after any type of gastrectomy the stomach empties more rapidly than normal (Pulvertaft, 1953; Brunsgaard, 1946; Shanks, 1934; Morley and Roberts, 1928; Goligher and Riley, 1952; Ravdin *et alii*, 1936 Wells and Macphie, 1952). Apart from the consistency of gastric contents, there appear to be three factors which might influence the rate of gastric emptying after gastrectomy; (1) gastric peristalsis; (2) duodenal and jejunal peristalsis, and (3) gravity.

The gastric remnant is incapable of strong peristaltic contraction, and Brunsgaard (1946) did not find any evidence of peristaltic activity in it. Jordan *et alii* (1957) have also recently studied the mobility of the gastric remnant and they found minimal peristaltic activity in it. They concluded that other factors than gastric contractions are responsible for gastric emptying after gastrectomy. Most observers describe what is usually seen on the X-ray screen, the opaque meal simply pouring through the gastric remnant. The mechanisms which influence gastric emptying are slightly different with the two types of restoration. Consider first the Billroth II type of operation. Apart from the peristalsis in the afferent and efferent loops and the effect of gravity, the size of the stoma may influence the rate of gastric emptying especially if this could function as a sphincter. The stoma is usually referred to as the opening between the stomach and small bowel at the site of anastomosis; Kennedy *et alii* (1947) however refer to the "true" stoma as the jejunum on the distal side of the anastomosis because the stomach can only empty as fast as the jejunum can accommodate its contents. The stoma can only control the rate of gastric emptying if it can act as a sphincter. The circular muscle of the stomach forms a complete ring at the level of the stoma, unless this is placed unusually high where the circular fibres are incomplete (Spalteholtz, 1923). However, as we have seen, this level of the stomach does not normally form deep peristaltic waves which might be adequate to function like a sphincter. No sphincteric action has been seen on the gastric side of the anastomosis by those who have looked for it (Kennedy *et alii*, 1947; Porter and Clamman, 1949; Pulvertaft, 1953; Brunsgaard, 1946; Shanks, 1934). The jejunum opposite the anastomosis is also unable to function as a sphincter. Cannon (1911) pointed out, if a piece of gut is divided longitudinally it cannot carry out effective contractions because as the circular muscle contracts it merely stretches the stoma transversely. The jejunum immediately distal to the anastomosis at least has the necessary criterion for sphincteric action; it has a complete circular muscle coat, it has the property of rhythmic contraction with a frequency in man of about 11 contractions/min., being smooth muscle it will be depolarized by stretch and will therefore respond by increasing tension, i.e., it will contract. Several investigators have seen sphincter-like action in this part (Kennedy, *et alii*, 1947; Porter and Claman, 1949; Pulvertaft, 1953; Brunsgaard, 1946); however, it is a poor sphincter and is not in any way analogous to the pyloric antrum-pylorus-duodenal cap mechanism. It is only when the tone of a long segment of jejunum is high that the stomach, aided by gravity, cannot pour any more fluid into the small bowel and this occurs only when the jejunum is full (Goligher and Riley, 1952; Pulvertaft, 1953; Brunsgaard, 1946). Porter and Claman (1949) believed that if the stoma was made smaller than the diameter of the jejunum the rate of gastric emptying may be decreased. There are two dangers in following this argument to its logical conclusion and making the stoma much smaller than the diameter of the jejunum. The first is the risk

of oedematus obstruction soon after operation, and the second is that the stomach remnant is incapable of ejecting its contents against resistance in the way that the normal pyloric antrum does. The physiology of both the stomach remnant and the small intestine in the region of the anastomosis is such that it seems unlikely that any mechanism comparable to a pyloric antrum, canal and duodenum, could be made by any surgical manoeuvre. The main value of the small stoma and the so-called valve lies not so much in the slowing of gastric emptying but in decreasing the reflux into the afferent loop (Goligher and Riley, 1952; Finsterer and Cunha, 1931; Ogilvie, 1935; Maingot, 1948; Mimpriss and Birt, 1948). The direction of chyme takes once it is in the jejunum must be greatly influenced by the direction of spread of jejunal contractions, peristaltic or antiperistaltic. It has already been mentioned that the frequency of true antiperistalsis in man in the duodenum, which comprises the afferent loop, has been debated. Wheelon (1923a) made the interesting observation that if barium was injected at the mid-point of the duodenum active antiperistalsis followed and the patient complained of feeling faint. It would therefore seem desirable to avoid reflux into the afferent loop even though such reflux is probably not the only cause of the dumping syndrome. The manner in which the valve accomplishes its effect is probably not that it functions as a valve in the mechanical sense, but because it preserves a greater length of jejunum able to continue normal peristaltic activity. In dogs and man the peristalsis of the duodenum and upper jejunum is more rapid and consistently aboral than lower down the jejunum and therefore has greater ability to force its contents away from the afferent loop. The greater the length of upper jejunum that is split longitudinally to form the stoma the greater the length of ineffective peristalsis, and ineffective peristalsis in this region favours duodenal reflux and increases the difficulty of the afferent loop emptying itself.

The mechanism controlling emptying after Billroth I type of restoration is different from the Billroth II because of the different characteristics of the upper duodenum to the upper jejunum. If the resection has been adequate for duodenal ulcer no antral musculature remains, but if even part of the antral muscle is left then some part of the normal mechanism of gastric evacuation is intact and this may affect gastric emptying. Schindler and Daily (1941) believed on gastroscopic evidence that any part of the antral musculature may have sprincter-like properties. Consequently the greater capacity of the stomach to retain some of its contents. Pulvertaft (1953) showed that the sprincteric action of the first part of the duodenum was normally more efficient than the upper jejunum, the reason for this being probably that the upper duodenum has the greatest frequency of contraction of the small intestine. Once the normal mechanisms have been destroyed any sphincter-like powers which may be developed by the gut could be of great value in decreasing the rate of gastric emptying.

In view of the importance of maintaining normal peristaltic activity in the duodenum and upper jejunum near the anastomosis, every effort should be made at operation to preserve the conducting mechanism in this region. The conduction along the bowel is rapidly blocked by the pressure of a spring bladed clamp, and if two clamps are placed across the bowel about 3 inches apart all electrical evidence for activity of the conducting mechanism (slow wave) disappears after ten minutes (Milton and Smith, unpublished). Usually conduction is rapidly restored once the clamps are removed, but in some cases the damage may be permanent. Thus in order to preserve the longitudinal conduction in the small bowel it would be preferable not to use clamps on the small intestine. However, if a clamp is to be used it should be as flexible as will permit haemostasis, and should be applied for the minimum time. The way the clamp is applied is also important. If the clamp is applied across the afferent loop the mesenteric attachment and efferent loop in one bite as in Fig. Va then the whole of the anastomotic area and the adjacent parts of the afferent and efferent loops become anoxic. Whereas if the clamp is applied to only part of the circumference of the small bowel (Fig. Vb), then a strip of normally conducting smooth muscle is left unaffected. The clamp on the stomach side of the anastomosis is not so important because the conducting mechanism cannot bridge the scar of the anastomosis in any case.

Welbourn (1956) reported a case in which the gastric stoma failed to function for twenty-four days and then spontaneously started to work. At no time did there appear to be any organic obstruction. I have also

seen a similar case in which there persisted an obstruction of which the gastric stoma without any evidence of organic obstruction found at jejunostomy and subsequent autopsy. Burge (1956) commenting on Welbourn's case stated that he had experienced difficulty with the emptying of the stomach remnant in early cases when he applied the jejunal clamp across the mesentery as well as the bowel (Fig. Vb). He had not seen this complication since he applied the clamp along the jejunum (Fig. Va). Burge believed that the delay in emptying may have been due to crushing vagal fibres in the mesentery although Welbourn had already pointed out that this complication was not commonly

It has been suggested that plication of the small bowel (Fig. VI) may be of value either to increase the capacity of the "stomach" (Hays, 1954) or as a means of treating bilious vomiting (Wells, 1955). Such operations may be adequate if the operator is satisfied with an inert sump, because such a plicated small bowel cannot be expected to function like a stomach or even healthy small intestine, because the conduction is not re-established across the anastomosis and the loops of intestine therefore conduct in different directions (Fig. VI). The emptying of such a sump therefore depends on gravity and the properties of the small bowel entering and leaving it.

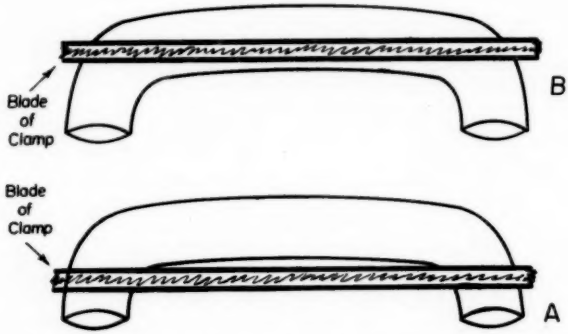

FIG. V. Two methods of applying an intestinal clamp to a loop of jejunum. Method A does not leave any of the bowel wall free from possible damage due to anoxia. Method B leaves a small rim of normally conducting muscle which can continue to transmit the co-ordinating electropotential wave.

seen after partial gastrectomy with vagotomy. If the ischaemia produced by the jejunal clamp destroyed the normal conducting mechanism then contraction of the jejunum in the anastomotic region would be as ineffective as the contraction of the ventricle in ventricular fibrillation of the heart. Small quantities of fluid would possibly be able to trickle across such a piece of gut and in this way bile and pancreatic juices would not be dammed back, but the intestine would not be able to empty a meal from the stomach rapidly.

Wells (1955) postulated that some forms of post-gastrectomy diarrhoea may arise from the "spill over" of activity from a distended afferent loop into the efferent loop. The conducting mechanism with small intestine might accomplish such a "spill over".

It has been shown that the symptoms referred to as the dumping syndrome may be produced by a variety of methods: distension of the jejunum if this is associated with a rise in pressure, hypermotility of the jejunum, dragging on the afferent or efferent loop or the stomach remnant, or the dragging effect of a mercury loaded bag (Welbourn, Butler and Capper, 1951; Wells and Macphie, 1952; Glazebrook and Welbourn, 1952; Capper, 1950-51; Butler and Capper, 1951; Capper and Butler, 1951). In spite of the apparent diversity of these methods it may be that the mechanism by which the symptoms are produced are the same in all of them. Recently Paintal (1954) and Iggo (1955, 1957) have studied the characteristics of nervous receptors in the gut wall which are sensitive to stretch or an increase in intraluminal pressure. These workers found that there exist

stretch receptors in the muscular coats of the stomach, duodenum and upper jejunum. Iggo (1957) has shown that these stretch receptors must lie in series with the muscle fibres of the gut wall because they are stimulated by passive stretching or by distension associated with a rise of pressure, or by powerful contractions of the gut wall. The afferent nerve fibres which carry the impulses to the brain have only been studied in the vagus, where they exist in appreciable numbers. There is no reason to suppose that similar small slow conducting fibres do not follow sympathetic pathways as well, indeed clinical evidence suggests that they do. Iggo (1957) found that the discharge of these receptors was greatest if the distension was rapid. He (personal communication) also found pinching or pulling the gut wall stimulated them. Consequently rapid distension with an increase in pressure, or powerful contraction of the gut wall would stimulate such receptors. Dragging on the gut by mercury loaded bags or sagging afferent and efferent loops would do the same thing. The fact that the symptoms are not abolished by atropine does not invalidate the argument, because, although the contraction may be eliminated in this way dragging would not be abolished, and atropine will only block the efferent vagal fibres which are cholinergic, and not the afferent fibres which carry impulses to the central nervous system, nor will it block the sympathetic afferent fibres. The observation that the symptoms of the dumping syndrome may occur after vagotomy probably indicates afferent fibres from receptors of this kind may pass by sympathetic nerves as well as the vagi. It is not unreasonable that rapid depletion of the extracellular fluid volume which occurs in the dumping syndrome (Peddie *et alii*, 1957) would accentuate any vasomotor reflexes initiated from tension receptors in the gut wall.

There has recently been some interest in the use of small intestine as a means of replacing the ureter, or oesophagus, or of enlarging the capacity of the bladder. The mechanical characteristics of the small intestine have a bearing on these operations. If a rapidly contracting conduit which will also limit reflux is required then jejunum would be preferable to ileum. A blind loop which empties in the direction of normal peristalsis will empty satisfactorily, but if a blind loop has to empty against the direction of peristalsis it will empty poorly and should therefore be avoided. Handley (1956) showed that the distal limb of a T ileo-cystoplasty filled easily from the bladder, emptied badly and tended to collect mucous, whereas the proximal limb, which empties in the direction of peristalsis, has none of these defects. The direction of peristalsis is predetermined and cannot be changed. If a piece of gut is reversed the animal will die of starvation before the direction of peristalsis reverses to allow the contents to pass on (Mall, 1896).

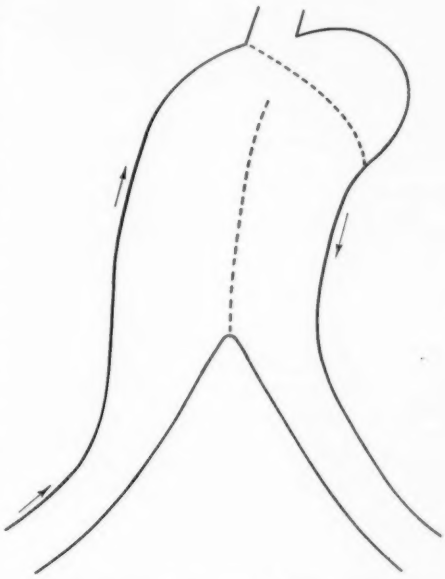

FIG. VI. Diagram of one of the methods of plicating the jejunum (modified from Wells). The arrows indicate the direction of peristalsis which will remain the same in each piece, because the conducting mechanism in the bowel wall cannot bridge an anastomosis nor is it normally reversible.

SUMMARY

Recent work on the physiology of gastrointestinal smooth muscle has been reviewed, it is concluded that:—

(1) The smooth muscle of the bowel wall is probably co-ordinated by a slowly spreading electrical wave, which spreads from cell to cell.

(2) The nerve plexuses in the bowel wall are not intimately related to the co-ordination of the gut musculature in the small intestine.

(3) The co-ordination of the smooth muscle is disturbed by an anastomosis, and may be damaged for months, at least, by the injudicious use of bowel clamps.

(4) The different electropotential waves which may be recorded from the small intestine have been reviewed.

(5) The mechanism of gastric emptying, and the possible methods of adaptation available to the gut following gastrectomy, are outlined.

(6) The manner in which post-gastrectomy dumping syndromes may be either initiated, or augmented, by vasomotor reflexes initiated from hyperactive bowel wall has been discussed.

(7) The different mechanical characteristics of different parts of the small intestine have been discussed in connection with the use of small intestine transplants in urology.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the help I have received from Professor John Loewenthal, Professor of Surgery, the University of Sydney, and to Mr. S. Woodward-Smith and his staff in the Department of Illustration. Figs. I and II are reproduced by courtesy of the Editor of the *Quarterly Journal of Experimental Physiology*, and Figs. III and IV from the *Journal of Physiology* by courtesy of the Editor.

REFERENCES

ALVAREZ, W. C. (1914), *Amer. J. Physiol.*, vol. 35, page 177.

AMBACHE, N. (1947), *J. Physiol. (Lond.)*, vol. 106, page 139.

ARMSTRONG, H. I. O., MILTON, G. W., and SMITH, A. W. M. (1956), *J. Physiol. (Lond.)*, vol. 131, page 147.

BAYLISS, W. M., and STARLING, E. H. (1899), *J. Physiol. (Lond.)*, vol. 24, page 99.

BERKSON, J. (1933), *Amer. J. Physiol.*, vol. 104, page 67.

——— BALDES, E. J., ALVAREZ, W. C. (1932), *Amer. J. Physiol.*, vol. 102, page 683.

BOULTON, C., and GOODHART, G. W. (1922), *Lancet*, vol. 1, page 420.

——— and SALMOND, W. A. (1927), *Lancet*, vol. 1, page 1230.

BOZLER, E. (1938), *Amer. J. Physiol.*, vol. 124, page 502.

——— (1939), *Amer. J. Physiol.*, vol. 127, page 301.

——— (1941), *Biol. Symp.*, vol. 3, page 95.

——— (1946), *Amer. J. Physiol.*, vol. 146, page 496.

——— (1948), *Experientia (Basel)*, vol. 4, page 213.

BRODY, D. A., and QUIGLEY, J. P. (1944), *J. Lab. Clin. Med.*, vol. 29, page 863.

BRUNSGAARD, C. (1946), *Acta chir. Scand.*, Suppl. XCIV, vol. 117, page 147.

BULBRING, E. (1954), *J. Physiol. (Lond.)*, vol. 125, page 302.

——— (1955), *J. Physiol. (Lond.)*, vol. 128, page 200.

———, BURNSTOCK, G., and HOLMAN, M. E. (1957), *J. Physiol. (Lond.)*, vol. 140, page 52 P.

———, and HOOTON, I. N. (1953), *J. Physiol. (Lond.)*, vol. 120, pages 8-9 P.

BURGE, H. (1956), *Brit. med. J.*, vol. 2, page 1428.

BUTLER, T. J., and CAPPER, W. M. (1951), *Brit. med. J.*, vol. 1, page 1177.

CANNON, W. B. (1898), *Amer. J. Physiol.*, vol. 1, page 359.

——— (1904), *Amer. J. Physiol.*, vol. 10, page 18.

——— (1911), "Mechanical Factors in Digestion". London. Arnold, page 80.

CAPPER, W. M. (1950-51), *Gastroenterologia (Basel)*, vol. 76, page 319.

——— and BUTLER, T. J. (1951), *Brit. med. J.*, vol. 2, page 265.

CAUSEY, G., and PALMER, E. (1949), *J. Physiol. (Lond.)*, vol. 109, page 220.

CODE, C. F., ROGERS, A. G., SCHLEGEL, J., HIGHTOWER, N. C., BORGEN, J. A. (1957), *Gastroenterology*, vol. 32, page 615.

CRIDER, J. O., and THOMAS, J. E. (1937), *Amer. J. dig. Dis.*, vol. 4, page 295.

DOUGLAS, D. M. (1948), *J. Physiol. (Lond.)*, vol. 107, page 472.

———, and MANN, F. C. (1939), *Amer. J. dig. Dis.*, vol. 6, page 318.

EVANS, D. H. L., and SCHILD, H. O. (1953, a), *J. Physiol. (Lond.)*, vol. 119, page 376.

——— ——— (1953, b), *J. Physiol. (Lond.)*, vol. 122, page 63 P.

FINSTERER, H., and CUNHA, F. (1931), *Surg. Gynec. Obstet.*, vol. 52, page 1099.

FOULK, W. T., CODE, C. F., MOROELK, G. G., and BORGEN, J. L. (1954), *Gastroenterology*, vol. 26, page 601.

GAITHNER, E. H. (1928), *J. Amer. med. Ass.*, vol. 91, page 1075.

GASKELL, W. H. (1882), *Phil. Trans. B.*, vol. 3, page 993.

GLAZEBROOK, A. J., and WELBOURN, R. B. (1952), *Brit. J. Surg.*, vol. 40, page 111.

GOLIGHER, J. C., and RILEY, T. R. (1952), *Lancet*, vol. 1, page 630.

HANDLEY, H. G. (1956), *Brit. J. Urol.*, vol. 28, page 402.

HAYS, R. P. (1954), *Surg. Forum*, page 291.

HERTZ, A. F. (1913), *Amer. Surg.*, vol. 58, page 466.

IGGO, A. (1955), *J. Physiol. (Lond.)*, vol. 128, page 593.

——— (1957), *Quart. J. exp. Physiol.*, vol. 42, page 130.

INGLEFINGER, F. J., and MOSS, R. E. (1942), *Amer. J. Physiol.*, vol. 136, page 561.

JORDAN, G. L., BARTON, H. L., WILLIAMSON, W. A. (1957), *Surg. Gynec. Obstet.*, vol. 104, page 257.

KEITH, A. (1915), *Lancet*, vol. 189, page 371.

KENNEDY, K. C. S., REYNOLDS, R. P., CANTOR, M. O. (1947), *Surgery*, vol. 22, page 41.

KNOCKINSKY, G., LULLMAN, H., and MUSCHOLL, E. (1954), *Naunyn-Schmiedeberg's Arch. exp. Path. Pharmak.*, vol. 223, page 369.

LEGROS and ONISUMS (1869), *J. Anat. (Paris)*, vol. 6, page 37.

MCLAREN, J. W., ARDAN, G. M., and SUTCLIFFE, J. (1950-51), *J. Fac. Radiol. (Lond)*, vol. 2, page 148.

MAINGOT, R. (1948), "Abdominal Operations". 2nd Ed. London. Lewis, page 229.

MALL, F. P. (1896), *Johns Hopk. Hosp. Rep.*, vol. 1, page 68.

MEDOFF, J. (1941), *Amer. J. Physiol.*, vol. 133, page 386.

MERING, J. VON (1897), *Verh. Kongr. inn Med.*, vol. 15, page 433.

MESCHAN, I., and QUIGLEY, J. P. (1938), *Amer. J. Physiol.*, vol. 121, page 350.

MILTON, G. W., and SMITH, A. W. M. (1956), *J. Physiol. (Lond.)*, vol. 132, page 100.

———, SMITH, A. W. M., and ARMSTRONG, H. I. O. (1955), *Quart. J. exp. Physiol.*, vol. 40, page 79.

MIMPRESS, T. W., and BIRT, St. J. M. C. (1948), *Brit. med. J.*, vol. 2, page 1095.

MORIN, G., and MONGES, A. (1951), *Arch. Mal. Appar. dig.*, vol. 5, page 185.

MORLEY, J., and ROBERTS, W. M. (1928), *Brit. J. Surg.*, vol. 16, page 239.

OGILVIE, W. H. (1935), *Brit. med. J.*, vol. 1, page 457.

PAINTAL, A. S. (1954), *J. Physiol. (Lond.)*, vol. 126, page 255.

PANNETT, C. A. (1921), *Brit. J. Surg.*, vol. 8, page 262.

PEDDIE, G. H., JORDAN, G. L., DE BAKEY, M. E. (1957), *Ann. Surg.*, vol. 146, page 892.

PORTER, H. W., and CLAMAM, Z. O. (1949), *Ann. Surg.*, vol. 129, page 417.

PPUNGEN, Von (1887), *Zbl. Physiol.*, vol. 1, pages 220 and 275.

PROSSER, C. L., SPERELAKIS, N., and BERGMAN, R. A. (1955), *Amer. J. Physiol.*, vol. 183, page 652.

——— and SPERELAKIS, N. (1956), *Amer. J. Physiol.*, vol. 187, page 536.

PUESTOW, C. B. (1933), *Amer. J. Physiol.*, vol. 106, page 682.

PULVERTAFT, C. N. (1953), *J. Fac. Radiol. (London)*, vol. 5, page 19.

——— (1954), *Lancet*, vol. 1, page 325.

QUIGLEY, J. P. (1941), *Amer. J. dig. Dis.*, vol. 8, page 363.

———, and BRODY, D. A. (1950), "Medical Physics", vol. 2, page 280, New York, Year Book Publishers.

———, and READ, M. R. (1942), *Amer. J. Physiol.*, vol. 137, page 234.

———, READ, M. R., RADZOW, K. H. (1942), *Amer. J. Physiol.*, vol. 137, page 153.

———, WERLE, J. M., LIDON, E. W., READ, M. R., RADZOW, K. H., MESCHAN, I. (1941), *Amer. J. Physiol.*, vol. 134, page 132.

———, ZETTLEMAN, H. J., and IVY, A. C. (1934), *Amer. J. Physiol.*, vol. 108, page 643.

RAVDIN, I. S., PENDERGRASS, E. P., JOHNSTON, C. G., HODES, P. I. (1936), *Amer. J. Roentgenol.*, vol. 35, page 306.

REYNELL, P. C., and SPRAY, G. H. (1956), *J. Physiol. (Lond.)*, vol. 131, page 452.

SALMOND, R. W. A. (1928), *Proc. roy. soc. Med.*, vol. 21, page 1361.

SCHINDLER, R., and DAILY, M. E. (1941), *Amer. J. dig. Dis.*, vol. 8, page 8.

SCHINZ, H. R., BAENSCH, W. F., FRIEDL, E., UHLINGER, E. (1954), "Roentgen Diagnostics." London, Heinmann, vol. 4, page 2345.

SHANKS, S. C. (1934), *Brit. med. J.*, vol. 2, page 1032.

———, JOHNSTONE, A. S., TEAL, C. G. (1950), "Textbook of Radiology by British Authors." London, Lewis, vol. 3, page 166.

SMITH, W. H., FRAZER, R., STAYNES, K., WILLCOX, J. M. (1953), *Lancet*, vol. 2, page 530.

SPALTEHOLTZ, W. (1923), "Hand Atlas of Human Anatomy." Philadelphia, Lippincott, vol. 3, page 533.

STANNIUS, H. (1852), *Arch. Anat. Physiol. (Lpz)*, page 85.

SWENSON, O. (1950), *Surgery*, vol. 28, page 371.

——— and BILL, A. H., Junr. (1948), *Surgery*, vol. 24, page 212.

———, RHINELANTHER, H. F., and DIAMOND, I. (1949), *New Engl. J. Med.*, vol. 241, page 551.

TEMPLETON, F. F. (1944), "X-ray Examination of the Stomach." Chicago, University of Chicago Press, page 163.

THOMSON, H. L. (1932), *Calif. West. Med.*, vol. 36, page 383.

WELBOURN, R. B. (1956), *Brit. med. J.*, vol. 2, page 1172.

———, BUTLER, T. J., and CAPPER, W. M. (1951), *Proc. roy. Soc. Med.*, vol. 44, page 773.

WELLS, C. (1955), *Ann. roy. Coll. Surg. Engl.*, vol. 16, page 145.

WELLS, C. A., and MACPHIE, I. W. (1952), *Lancet*, vol. 2, page 1189.

WERLE, J. M., BRODY, D. A., LIDON, E. W., READ, M. R., and QUIGLEY, J. P. (1941), *Amer. J. Physiol.*, vol. 131, page 606.

WHEELON, H. (1923a), *J. Amer. med. Ass.*, vol. 80, page 615.

——— (1923b), *N.Y. med J.*, vol. 117, page 652.

——— and THOMAS, J. E. (1922), *Amer. J. Physiol.*, vol. 59, page 72.

A SIMPLE METHOD FOR THE OXYGENATION OF HEPARINIZED VENOUS BLOOD

By Douglas Cohen

Congenital Heart Disease Unit and the Institute of Child Health, Royal Alexandra Hospital for Children, Sydney

THE increasing use of hypothermia for intracardiac surgery has made it apparent that temporary circulatory arrest may result in anoxia of the myocardium, and that this factor, combined with the handling of the heart that is necessary to carry out various operative procedures, will not infrequently result in ventricular fibrillation, which may be extremely difficult to revert in the cold heart. Swan (1954), who has probably had a greater experience of this technique than any other worker, has stated "the asphyxiated, manipulated, cold, abnormal heart is particularly prone to enter ventricular fibrillation at the time when an attempt is being made to restore circulation." In an extensive series of cases reported by this worker, the incidence of ventricular fibrillation in a series of 100 cases under hypothermia was 15 per cent. Ten per cent. of these occurred during or immediately after cardiac manipulation, and only three of these were long term survivors. Shumway, Gliedman and Lewis (1955) have reported that ventricular fibrillation was the most disturbing complication encountered during the repair of atrial septal defects under hypothermia with circulatory occlusion. It occurred in 11 out of 35 patients who underwent operation at their hands and 9 of these cases occurred during the actual operative procedure on the heart. A number of workers have shown that the effects of anoxia on the myocardium are very important in this regard and that they can be minimized by the perfusion of warm, oxygenated, heparinized blood through the coronary circulation during the time of circulatory arrest. Bahnson and Spencer of John Hopkins Hospital, during a series of intracardiac operations under hypothermia performed at the Royal Prince Alfred Hospital, Sydney, utilized this technique and demonstrated conclusively that the maintenance of normal cardiac rhythm during the period of circulatory arrest and the recovery of normal arterial blood pressure following restoration of the circulation are materially assisted by the use of this technique. Maloney, Marable and Longmire (1958) in a series of 12 cases of open repair of atrial septal defects under hypothermia, showed convincingly that the use of coronary perfusion significantly reduced the incidence of ventricular fibrillation and other less serious cardiac irregularities during the period of circulatory arrest.

The usual method of obtaining heparinized, oxygenated blood, as originally described by Warden *et alii* (1955) has been to warm the donor's arm for 30 minutes in a water bath at 45°C while the donor inhales 100 per cent. oxygen. The blood thus obtained is usually at least 90 per cent. oxygenated but this, as Lillehei himself admits, is not invariable and in some cases the oxygen saturation is considerably below the optimal level. In addition, since the blood must be obtained shortly before it is required, some inconvenience is caused both to the donor and to the Blood Bank when this technique is utilized and, since a satisfactory degree of oxygen saturation is not invariably achieved, the blood thus collected may prove to be unsuitable in certain cases. Therefore, a simpler and more positive technique for the collection and preparation of heparinized, oxygenated blood would appear to have something to recommend it. The technique to be described has the virtue of simplicity, and, following oxygenation, the blood has proved to be fully saturated in every case.

Method

The blood is collected by the Red Cross Blood Bank approximately one hour before it is required. Instead of the usual citrate mixture, blood is collected into bottles containing 2,500 units of heparin per 500 mls. of blood; otherwise the usual standard technique

of collection is employed. Oxygenation of the fresh, venous, heparinized blood thus collected is carried out as follows:—

Oxygen flowing at a rate of approximately 3 litres per minute, after being passed through any standard filter as a precaution against bacterial contamination of the blood, is introduced via a needle passed through the stopper of the flask of blood and is allowed to run into the air space above the blood for a period of 5-10 seconds, thus building up a positive pressure of 250-400 mm. of mercury within the flask. No bubbles of oxygen are actually passed through the blood in the flask. The needle is then withdrawn and the blood agitated gently so as not to produce frothing, and adequate mixing of the oxygen with the blood is thus achieved. This rapidly produces full oxygenation of the blood within the flask. If desired, the procedure can be repeated, should the blood not appear fully oxygenated to the naked eye, but in practice this rarely proves to be necessary. Fully oxygenated, fresh, heparinized blood is thus very rapidly and simply prepared by this technique and is then stored in a water bath at 35°C until it is required. After circulatory arrest is produced by occlusion of the venae cavae, the aorta is occluded as high as possible and a number 18 gauge needle is inserted into it and blood is perfused, under mild positive pressure, at a rate of approximately 3 ml. per kilogram per minute. 500 ml. of blood, or less proves to be more than adequate for the vast majority of cases in which this technique is utilized.

SUMMARY

The use of coronary perfusion of fresh oxygenated heparinized blood as an adjunct to hypothermia during intracardiac surgery is discussed and a simple method for the preparation of the fresh heparinized, oxygenated blood is described.

ACKNOWLEDGEMENTS

This work was carried out whilst working under a part-time Commonwealth grant from the Institute of Child Health, Sydney, which has made it possible to undertake this and other investigational work in the field of cardiovascular surgery. I am sincerely grateful to Professor Lorimer Dods for his very material assistance and encouragement.

My thanks are also due to Mr. John Jackson, senior technician of the Congenital Heart Disease Unit at the Royal Alexandra Hospital for Children, who carried out the numerous blood-gas analyses necessary to confirm the efficiency of this technique.

Also to the Red Cross Blood Bank, and, in particular, Dr. R. J. Walsh and Dr. G. J. Archer for their co-operation in supplying fresh, heparinized blood on several occasions when required either for preliminary tests or for clinical cases.

Dr. H. Kronenberg, Pathologist at Royal Prince Alfred Hospital, has kindly checked the results of blood-gas analysis on a number of occasions and informs me that this procedure has proved to be quite satisfactory in his hands and is being adopted as standard practice when fresh, heparinized oxygenated blood is required in their Unit.

REFERENCES

COOKSON, D. A. and COSTAS-DURIEUX, J. (1954), *Ann. Surg.*, vol. 140, page 100.

MALONEY, J. V., MARABLE, S. and LONGMIRE, W. P. (1957), *J. thorac. Surg.*, vol. 34, page 580.

RIBERI, A., GRICE, P., RODRIGUEZ, R., KAJIKURI, H. and SHUMACKER, H. B. (1956), *J. thorac. Surg.*, vol. 32, page 399.

SHUMWAY, N. E., GLIEDMAN, M. L. and LEWIS, F. J. (1955), *J. thorac. Surg.*, vol. 30, page 598.

SWAN, H. (1954), quoted by Maloney *et alii*.

WARDEN, H. E., READ, R. C., DE WALL, R. A., AUST, J. B., COHEN, M., ZIEGLER, N. R., VARCO, R. L. and LILLEHEI, C. W. (1955), *J. thorac. Surg.*, vol. 30, page 649.

FLUOTHANE

By H. D. O'Brien

St. Vincent's Hospital, Melbourne

It is nearly two years since Raventos (1956) conducted a series of promising animal trials on a new drug prepared by Suckling of Imperial Chemical Industries, Manchester. Supplies of the drug were made available for a clinical assessment to Johnstone at the Royal Infirmary, Manchester, and to the Nuffield Department of Anaesthetics, Oxford, where Bryce-Smith and I administered it to a series of over 500 cases.

Results of a reasonably encouraging nature were announced (Johnstone, 1956; Bryce-Smith and O'Brien, 1956) and a number of subsequent clinical trials in England, U.S.A., Canada and here in Australia have likewise suggested that this is a drug which is likely to fill a useful, if perhaps limited, place in anaesthesia.

It has been named Fluothane by I.C.I. and has been given the British Pharmacopoeia name of Halothane, but will possibly be differently labelled in the United States Pharmacopoeia, as an industrial fluorinated compound already goes by that name in that country.

It is a volatile, clear, colourless liquid with a specific gravity of 1.86 and B.P. of 50.2°C. It has a vapour with a sweetish odour rather similar to that of chloroform. Chemically, it is a halogenated ethane which is non-flammable and non-explosive in concentrations of 0.5 per cent. to 50 per cent. in oxygen, and can even extinguish flame. It has an oil-water solubility ratio of 330 compared to 100 for chloroform and 3.2 for ether.

Fluothane was not discovered by chance (Suckling, 1957). It was deliberately prepared, along with a number of other mostly fluorinated compounds, with the following data in mind.

A large number of halogen atoms in a molecule will usually confer non-flammability on a compound, and fluorine atoms will confer a low boiling point. For example if all the fluorine atoms in Fluothane were replaced by chlorine, then the boiling point would not be so low, probably about 160°C., and thus the compound would not be sufficiently volatile.

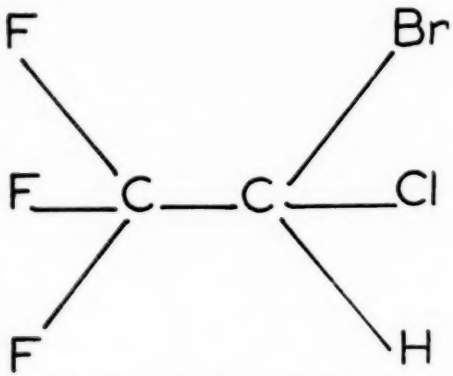

FIG. I. The chemical structure of Fluothane.

It must be remembered that at least one hydrogen atom is required in the molecule to make it pharmacologically active, and thus if all the atoms were halogens, it would be pharmacologically quite inert. Thus it is that only two out of about one hundred new fluorine compounds have reached clinical trial, e.g., an isomer of Fluothane is not stable over soda-lime and was therefore not submitted for trial. Also eliminated were most other halogenated aliphatics because they are gases at normal temperature and pressure, and are convulsants. Fluoroaliphatic compounds are more stable than and also have quite different properties from other halide aliphatics, because the carbon-fluorine bonds are more stable than those of other halogens, and are also less potent. It appears that there is not much chance of finding another fluorinated compound with more suitable properties than Fluothane.

The fluorine atom is more electro-negative than the other halogen atoms, and it is therefore more strongly bound to its own carbon atom than are the other halogen atoms in the molecule. Further, this strong electro-nega-

tive potential tends to weaken the linkage of the hydrogen, chlorine and bromine atoms to the other carbon atom, so that one might expect liberation of the bromine or chlorine, at least on theoretical grounds. However, clinically, there has been little, if any, evidence of any effect of a decomposition product, although decomposition is known to occur in the presence of light and moisture with air or oxygen. Even in the absence of these factors rapid reactions occur with certain metal alloys producing the bromide or chloride of tin on the tin foil of bottle caps or attacking aluminum surfaces so frequently used in anaesthetic apparatus. Corrosion will occur unless suitable metals are used or aluminum and tin surfaces are protected by anodizing or by coating with nylon, or other protective substances.

Fluothane seems to have an action on rubber. Rubber corks on drop bottles become swollen, rubber corrugated hosing slips easily from metal connections and breathing bags tend to perish more quickly than would otherwise be expected. However, after a period of exposure to a Fluothane-free atmosphere, rubber seems to return to its normal condition as a rule.

Apart from the need for protecting apparatus, decomposition should not otherwise be regarded more seriously than with other agents.

After reports of the first two clinical trials, the British Medical Research Council Committee on Non-Explosive Anaesthetics (1957) conducted an investigation into the pharmacology and to the clinical uses of Fluothane. The Committee issued a comprehensive report of their investigations, but the number of clinical cases on which the report was based was not large, and since then, although there have been a large number of clinical trials reported, unfortunately very little pharmacological work of a really searching nature has been reported.

METHODS OF ADMINISTRATION

A variety of methods have been devised. Since Fluothane is a relatively volatile liquid it can be administered by the open drop method. In my series with Bryce-Smith (Bryce-Smith and O'Brien, 1956) over 150 patients had open drop inductions, 44 of these having a preliminary injection of thiopentone. In most instances the induction was smooth, and seemingly pleasant, producing unconsciousness within about one minute. Swallowing during induction was common, but did not interfere with the administration and was never followed by vomiting. Coughing was rare, and when it did occur it was always relieved by withdrawing the Fluothane momentarily. Struggling and breath-holding were unusual, but on occasions, especially if no thiopentone had been given, there was a short period of restlessness. During breath-holding, inflation could always be easily performed. There was never a suggestion of spasm, as seen with ether. The absence of pharyngeal secretions was noticeable, and early relaxation of the masseters made possible the insertion of an oral airway after the first 5 or 10 breaths. Likewise a laryngoscope blade could be inserted at an early stage. Using the E.M.O. Inhaler (Epstein and Macintosh, 1956) it was found that the minimal concentration of Fluothane in air that regularly produce loss of consciousness was 1 per cent. Volunteers inhaled 0.5 per cent. Fluothane in air for up to 10 minutes, without loss of consciousness; 2 per cent. will produce surgical anaesthesia in most subjects.

Surgical intervention could often be tolerated after three or four minutes, although a further five to six minutes were necessary if the surgical stimulus was to be severe. In 58 cases the open drop method of anaesthesia was maintained throughout the operation, although this has the disadvantage of delivering unknown concentrations, and is wasteful. In the remainder of the cases the open drop induction was followed by maintenance with open ether, or Fluothane mixtures from an E.M.O. Inhaler which had been modified and calibrated to deliver known concentrations of the vapour in air. A mixture of nitrous oxide, oxygen and Fluothane using the calibrated E.M.O. Inhaler as a substitute for the Trilene bottle of a Boyle's machine has also been used to follow up induction with open drop Fluothane.

Another thermocompensated device which delivers very accurate concentrations is the "Fluotec". Specially designed Boyle's bottles are available, with a chart from which can be determined the percentage being delivered in varying circumstances, but this is less accurate than the above inhalers, and more cumbersome.

Fluothane can be vaporised by passing a constant flow of oxygen over Fluothane in a container at average room temperature (Cole,

1958) and conducting this through the cyclopropane rotameter and diluting this Fluothane rich mixture with oxygen metered through the oxygen rotameter thus giving a known concentration of Fluothane.

It is claimed that a concentration of 30 per cent. Fluothane will develop in a closed container, standing at 20° C. (Johnstone, 1957) and vaporisers which do not allow for this should be turned on very cautiously.

FLUOTHANE AND THE CLOSED CIRCUIT

This seems to be somewhat of a vexed question. There have been large series of cases reported where Fluothane has been used in a closed circuit and this method of administration seems to be more-or-less a necessity in view of the very high cost of this drug.

It may be of interest to note that there is little prospect of an appreciable reduction in price, for probably two years. This is due to the fact that, quite understandably, the manufacturers are unwilling to construct an adequate mass-production unit until they are assured of a continued demand for this drug. As a consequence it is obvious that people will turn to the closed circuit as a means of making the use of Fluothane an economical proposition.

Marrett (1957) has published a series of 1,500 successful cases in which Fluothane was used in a closed circuit, and therefore there can be no doubt that it is practical to use the drug in this manner. However, some criticism has been directed at this method because it does have the fundamental disadvantage, that even if a known concentration be entrained into the closed circuit, after a time it is impossible to be sure, with sufficient accuracy, of the actual concentration within the circuit, and especially so when the concentration is being reduced. As long as spontaneous respiration remains, this is not such a tremendous disadvantage, and of course the closed circuit has been used with ether and cyclopropane for many years, with adequate safety. Further, a spill of gases from the circuit must greatly increase the safety factor.

It may be argued that since there is an apparent parallel between blood pressure and pulse readings, and the depth of Fluothane anaesthesia, that controlled respiration likewise is quite safe in the hands of a skilled anaesthetist who already has had some considerable experience in the use of the drug with less complicated means. It will shortly be shown that, although this is commonly true of the blood pressure and pulse, it is not invariably so. It must be borne in mind, also, that the majority of cases in which major complications have occurred, have been those in which the drug has been administered in a system in which the concentration has not been accurately known, i.e., in a closed circuit and often with controlled respiration, or in cases where the drug has been administered from an apparatus which was not accurately calibrated or thermocompensated. The bulk of accidents with Fluothane have occurred when the concentration of the drug being administered to the patient was not certainly known by the anaesthetist.

It therefore must be acknowledged that even in skilled hands accustomed to the use of Fluothane, the practice of controlled respiration with a closed circuit should be undertaken with great caution. On the other hand, controlled respiration with accurately-known concentrations does not appear to be contra-indicated.

Foster (1957) has fully reported one death following a cardiac arrest under Fluothane anaesthesia. The circumstances were the administration of Fluothane with a muscle relaxant of the non-depolarizing type with controlled and assisted respiration through a circle absorber. A cardiac massage was performed but the patient did not regain consciousness and died after ten days. Other cases of cardiac arrest have been reported. An American series of 1,500 cases included 3 cardiac arrests in the first 100, but none in the remaining 1,400. These cases in the first 100 were all administered without accurate knowledge of the concentration of the drug and using a variety of techniques, including closed circuits. All three of these patients made complete recoveries. A Canadian series of more than 1,100 cases included 2 cardiac arrests, both of whom recovered (Hudson, 1957). It was later discovered that the machine which was in use for these two cases had a defective oxygen outlet and undoubtedly there was hypoxia, as a complicating factor. It is suggested with reference to circle absorbers that it is dangerous to have the vaporiser actually in the circuit, and that it is best to have the vaporiser delivering vapour into the gas inlet of the system.

An analyser which can be inserted into a circle absorber is in a late stage of development in England, and may prove to be the answer to the problem of using Fluothane by closed technique.

SIGNS OF ANAESTHESIA

There are certain characteristic features of anaesthesia under Fluothane, but reliable signs of the depth are few. Early in the administration there appears a flushing of the skin which becomes warm and dry. Suffusion of the conjunctival vessels and dilatation of superficial veins of the limbs. There is early relaxation of masseter muscles and depression of pharyngeal reflexes. There is an absence of pharyngeal secretions although swallowing is quite common. Even at an early stage, stimulation of the vocal cords will result in closure of the glottis, perhaps a cough, but certainly not the type of spasm to which one has become accustomed with other anaesthetic agents and intubation can be performed much more quickly than with other inhalational agents.

PHARMACOLOGY

Effects of Fluothane on the respiratory system

As a rule the depth of respiration decreases and the rate of respiration increases during the course of an anaesthetic. This was apparent clinically and at times was sufficient to cause cyanosis unless respiration was assisted or oxygen added to the inspired mixture of Fluothane and air. Fluothane was administered to some unpremedicated volunteers and also to patients, and minute volumes of less than two litres per minute have been recorded after only five minutes of 1 per cent. Fluothane, but such degrees of depression were unusual. Since the rate and depth of respiration were less constantly related to the depth of anaesthesia, than when using ether, these signs became a less useful guide to the stage of anaesthesia, and indeed reliable signs as to the stage of anaesthesia are conspicuously absent. The effects of premedication appear to be that with lighter premedication of atropine alone or with 50 mgms. of pethedine the depression of respiration was of a less profound nature than with heavy premedication.

TABLE 1

MINUTE VOLUMES

Recorded after 5 minutes inhalation of 1 per cent. Fluothane.

Premedication:	Pethidine 50 mg. Atrophine gr. 1/100	Omnopon gr. 1/3. Scopolamine gr. 1/150.
6 litres/min. or over	26 per cent.	19 per cent.
3.1-5.9 litres/min.	44 per cent. of 54 cases	35 per cent. of 71 cases
3.0 litres/min. or less	30 per cent.	46 per cent.

Illustrates the influence of heavy premedication compared with light premedication on patients inhaling Fluothane.

Respiratory depression can occur with very light anaesthesia, but usually with deeper planes. Other guides include the pulse rate and blood pressure which tend to fall simultaneously, but again not in 100 per cent. of cases. Jenkins (1957) claims that miosis occurs in the third stage of surgical anaesthesia. Monitoring of heart sounds proved of some value in determining the stage of cyclopropane and ether anaesthesia, but they are not constant enough under Fluothane anaesthesia to be of any particular worth (Given *et alii*, 1957).

The vapour is not irritating to the respiratory tract, and if desired, respiration can usually be controlled with the greatest of ease at light levels of anaesthesia. Up to 1.5 per cent. Fluothane in air was inhaled by volunteers in Oxford without any sensation of suffocation or irritation and the respiration was of a smooth and quiet character. Occasionally induction was interrupted by periods

of apnea, sometimes lasting for one or two minutes. The apnea was not a response to high concentration of Fluothane and differed from active breath-holding or spasm, as inflation with O_2 could be performed with perfect ease. Spontaneous respiration could be started after applying a painful stimulus to the patient.

TABLE 2

BLOOD PRESSURE VARIATION

(mm. Hg. systolic)

	1 per cent.	1.5 per cent.	2 per cent.
No. of cases	70	20	24
Max. Fall	75 (from 140)	100 (from 160)	70 (from 140)
Min. Fall	+10	+10	5
Average Fall	18	34	31
No. with no Fall or a rise in B.P.	21	4	1

All patients received Thiopentone 0.25 Gm.

Illustrates the falls in blood pressure which occurred in patients inhaling 1, 1.5 and 2 per cent. Fluothane. With 1 per cent. and 1.5 per cent. there were patients who had no fall in blood pressure but all patients inhaling 2 per cent. did have some fall in blood pressure. It also illustrates the wide variation between maximum and minimum blood pressure falls in patients inhaling a given concentration of Fluothane.

Fluothane and the circulatory system

The first report of clinical work with Fluothane was by Johnstone (1956) and was based on electrocardiographic findings in patients under Fluothane anaesthesia. He found cardiac arrhythmias to be rare under Fluothane, but that a bradycardia occurred almost constantly, with rates of 60-70 being the average. Raventos found the E.C.G. of dogs breathing 4 per cent. showed no change other than a decreased voltage. Forty-five of the Medical Research Council's cases had an E.C.G. and 6 of these showed cardiac disturbances. In passing we may note that there were 3 disturbances of rhythm in those who did not have E.C.G.'s, making a total of 9 in 258. Of the 6 irregularities noted under E.C.G. one had inverted "T" waves changed to upright "T" waves, 3 cases had short bursts of extra systoles and 2 cases had A.V. nodal rhythm, and one of these had short bursts of bundle branch block. Pre-existing arrhythmias have not been affected.

Effects on blood pressure

Most patients anaesthetized with 1-2 per cent. Fluothane have a fall in blood pressure, and frequently, but not constantly, the fall is proportional to the depth of anaesthesia, i.e., more blood pressure falls occur with 2 per cent. than with 1 per cent. However, there are some patients who will not have a fall in blood pressure, and may even have an increase. Of those who experience a fall, the majority have only a small drop in blood pressure—of the order of 10 or 20 mm. Hg., and those with larger falls are much less numerous.

Indeed, from the warm dry skin and the strong pulse which could be felt at any of the classical points of palpation it was often hard to believe that any blood pressure fall had occurred at all. The fall in blood pressure did not seem to be accentuated to any appreciable degree by the use of thiopentone. This provides a relatively bloodless operating field, quite similar to that obtained when hypotension is deliberately produced by other methods, but is probably less hazardous as it appears that Fluothane causes a depression of body metabolism. With the exception of a brief period of mental confusion in the post-operative phase in one elderly patient no ill effects were seen either from the slow pulse rate or from the low blood pressure in the Oxford series. The blood pressure and pulse rate tend to follow one another, but not invariably. A rise in the pulse rate was often followed by a rise in blood pressure and thus one comes to rely on atropine as an antidote to hypotension rather than methyl-amphetamine or such substances.

Effects on cardiac rate

The pulse rate in most cases becomes slower very shortly after the commencement of inhalation of Fluothane, and frequently falls as the depth of anaesthesia increases, and on occasions I have seen rates as slow as 40 per minute. Premedication with atropine, or administered during anaesthesia will prevent undesirably profound bradycardia.

Effects on cardiac output and on autonomic ganglia

The pharmacological reports on animal experiments by Raventos (1956) and the Medical Research Council (1957) are at variance on these two subjects. Raventos found that it had no depressing action on

cardiac muscle, nor on cardiac output, and claimed that it was a ganglionic blocking agent of sufficient strength to account for blood pressure falls. The Medical Research Council Committee could not agree with his findings on any of these points.

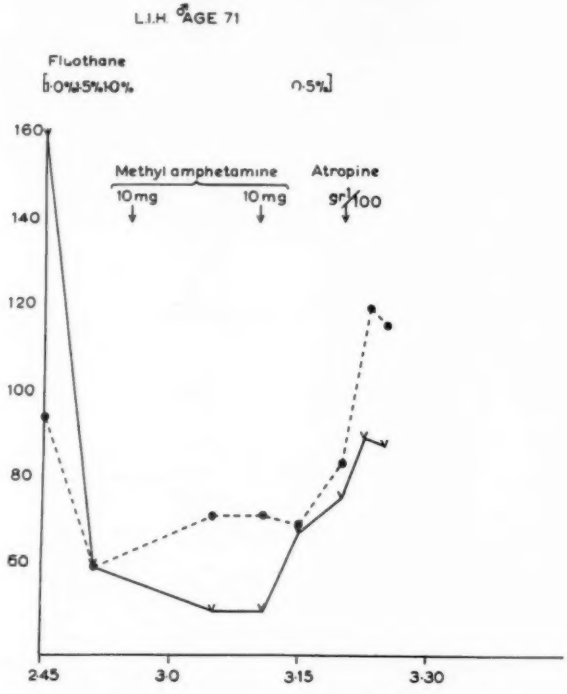

FIG. II. This shows a big fall in systolic blood pressure, a moderate response to methyl-amphetamine, and a better response to atropine. (Solid line represents systolic blood pressure; interrupted line represents pulse rate.)

They found falls in cardiac output varying from 5.1 per cent. to 53 per cent. on dog heart lung preparations with Fluothane anaesthetics, and it may be noted that 1.2 per cent. chloroform produced the same fall as 1.7 per cent. Fluothane; thus Fluothane has up to 70 per cent. of chloroform's action in the reduction of cardiac output. Ten per cent. ether or 2 per cent. trichlorethylene produced only small falls in cardiac output, the maximum being 10 per cent. and 4.8 per cent. respectively. They also found, in experiments on the cat-nictitating membrane and on the blood pressure of eviscerated cats, that Fluothane has a much greater effect in dropping blood pressure than in blocking sympathetic transmission to the nictitating membrane. It does to some degree weaken ganglionic transmission, but not enough to account for the blood pressure fall. Likewise it has been shown that it has not much action on the para-sympathetic cardiac ganglia. Depression of the knee jerk runs parallel with drop in blood pressure and the Medical Research Council Committee suggests that Fluothane causes central depression and the resulting central autonomic paralysis causes a blood pressure drop.

Action of neuromuscular junction

Fluothane (4.4 per cent.) failed to reduce the muscle twitch in the cat-soleous preparation, but comparisons of effect in the presence or absence of relaxants showed a change, namely d-tubocurarine caused an increase in muscle twitch and succinyl choline a decrease. This suggests that some synergism occurs with the depolarizing type of relaxants at the neuromuscular junction in cats.

Gallamine triethiodide was administered to a series of patients, and in many of these there has been a fall in blood pressure, but the extent of the fall has been little more than might be expected with Fluothane alone.

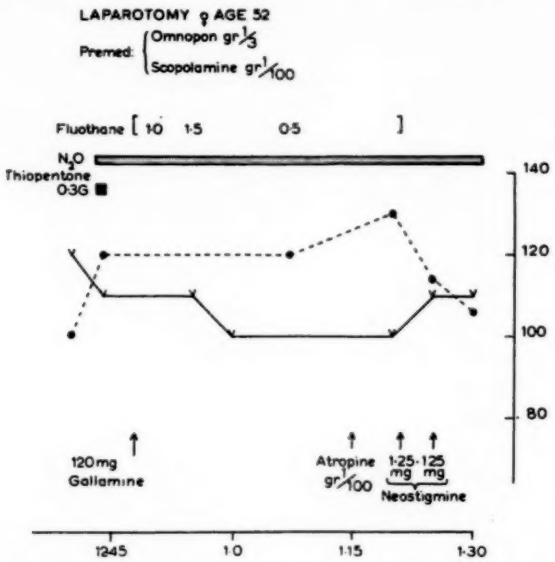

FIG. III. This graph illustrates the small drop in blood pressure which follows administration of gallamine.

In about half of the cases there was in fact a slight rise in blood pressure, coinciding with the rise in pulse rate which is characteristic of gallamine. When d-tubocurarine was administered the picture was different—falls in blood pressure were common and occasionally profound. They were most commonly seen with a pre-existing bradycardia, when the concentration of Fluothane was high, and when respiration was controlled.

There was no clinical evidence of decreased relaxation with d-tubocurarine as the Medical Research Council findings might suggest would occur, at least in cats. The use of non-depolarizing agents will frequently necessitate the use of neostigmine. The bradycardia produced by this drug combined with that produced by Fluothane can be rather profound, and as a consequence a full dose of atropine should be administered before giving the neostigmine, and the latter is best given in divided doses. With less cautious dosage there may be a profound slowing of the pulse.

THE USE OF ADRENALIN WITH FLUOTHANE

Raventos (1956) found in animal experiments that sensitivity of the heart to adrenalin given intravenously was increased by Fluothane to a greater degree than by chloroform, but to a lesser degree than by cyclopropane. However, when given intramuscularly or subcutaneously, adrenalin could be given in very large doses without disturbances of conduction. Doses of up to 5 cc. of 1 in 1,000 or 2 cc. of 1 in 100,000 were given without effect. However, other observers suggest that the human heart is sensitized by Fluothane. A Canadian report (Stephen *et alii*, 1957) states that the normal human myocardium is sensitized to adrenalin but not to peripherally acting vasopressors. In three different series of cases (Bryce-Smith and O'Brien, 1956; Jenkins, 1957; Marrett, 1957), no clinical troubles were encountered with the use of adrenalin, but another Canadian series (Stephen *et alii*, 1957) showed that cardiac irregularities, viz., ventricular extrasystoles, do occur when Fluothane is administered in the presence of injected adrenalin, and it does seem fairly certain that the use of Fluothane in the presence of injected adrenalin is not without risk. Brennan (1957) states that adrenolytic agents should also be used with

some caution in the presence of Fluothane, e.g., the antagonist to hypotensive episodes produced by chlorpromazine is nor-adrenalin, and to use this with Fluothane would possibly precipitate ventricular fibrillation.

an increased sensitivity to insulin for some twelve hours after Fluothane anaesthesia, but this can be counteracted by giving 500 to 1,000 ccs. of 5 per cent. glucose intravenously during the anaesthetic.

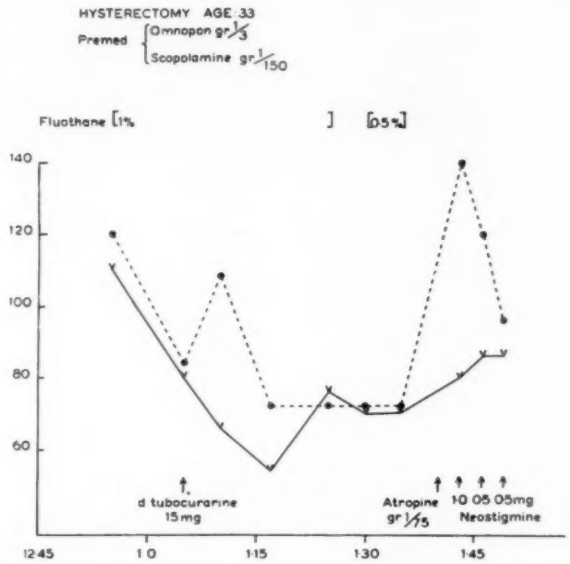

FIG. IV. Illustrates the more profound falls in blood pressure commonly encountered with d-tubo-curarine.

Liver and renal function tests

These showed some mild impairment in a few of the cases in the Medical Research Council's series, but none apparently attributable to the anaesthetic. In America, there has been one case of acute yellow atrophy of the liver which occurred following a Fluothane anaesthetic, and apparently there seems to be no evidence of any likely precipitating cause (Virtue, 1958). Hence, it is difficult to free the anaesthetic from blame.

Fluothane and Intercurrent Diseases

In my own series, Fluothane was administered to patients with a variety of pre-operative conditions, including diabetes, obstructive jaundice, cardiac failure, thyrotoxicosis and asthma, and it appears that none were adversely affected by the anaesthetic. However, it has been claimed that diabetics show

Fluothane and Regional Anaesthetics

Fluothane has been administered to patients having both spinal and caudal anaesthetics without obvious adverse effect. However, when administering Fluothane with local anaesthetic agents, it should be borne in mind that there is considerable evidence that the adrenalin which may be used in such solutions may cause adverse cardiac reactions under Fluothane anaesthesia.

Muscular Relaxation with Fluothane

Quick relaxation of the masseter muscles is quite a feature. This effect enabled an airway or laryngoscope blade to be inserted very early during the anaesthetic. Abdominal musculature was well relaxed in children, but in adults it was sometimes difficult to achieve adequate relaxation for abdominal surgery, especially in robust subjects and for operations in the upper abdomen.

FLUOTHANE IN OBSTETRICS

It causes profound uterine muscular relaxation and may interfere with post-partum retraction of the uterus, thus predisposing to severe haemorrhage. Johnstone (1957) claims that the bleeding can be controlled by lightening the anaesthetic. A further factor relevant to obstetrics is that Fluothane appears to cause a foetal bradycardia as well as a maternal one. This may produce a complicating factor for the obstetrician, as he will have to decide whether the alteration in foetal pulse rate is due to the anaesthetic or whether in fact it is due to foetal distress.

THE AFTER-EFFECTS OF FLUOTHANE

Recovery from Fluothane anaesthesia is reasonably rapid unless the anaesthetic has been very prolonged and completed with the patient still in a deep plane, with consequent respiratory depression and therefore the inability to exhale the drug rapidly. If anaesthesia is lightened towards the end of the operation, then recovery is indeed quite rapid. The sensation of awakening is quite a pleasant one and mental alertness is quickly restored, although a sensation of lassitude tends to persist for some time. On recovery there was usually a minimum of nausea and vomiting.

In a Canadian series of cases (Chang, 1957) 4 to 8 per cent. of cases vomited after Fluothane anaesthesia. Johnstone and his associates (1957) in a series of 2,500 cases found that only 6 per cent. of their patients vomited following recovery of consciousness after Fluothane anaesthesia. The Medical Research Council's series, which was a smaller one, 258 cases, reports of vomiting in 28 per cent. of patients.

Raventos (1956) noted that none of the 48 dogs whom he had anaesthetized vomited after Fluothane, but more than 50 per cent. of dogs vomited after anaesthetics with ether or cyclopropane. Shivering has been noted by several observers (Johnstone, 1957; Bryce-Smith and O'Brien, 1956) after Fluothane anaesthetics. This has not been of any great importance, but I have seen one case in which it was very severe although short-lived. It has been suggested by Johnstone that shivering is due to heat loss from vasodilatation with Fluothane. There are other general anaesthetic agents which are vasodilators and yet this phenomenon does not appear to be so common after them.

CONCLUSIONS

Fluothane has some very attractive properties; it is non-explosive and non-flammable. It is easily administered, by simple techniques if desired. It provides a pleasant, rapid and smooth induction and a reasonably quick recovery. Respiration can be easily and safely controlled, provided accurately known concentrations are employed. Absence of spasm, depression of secretions and of laryngeal and pharyngeal reflexes make the insertion of laryngeal and pharyngeal airways very easy. The suppression of haemorrhage from the operation site seems to be more than commensurate with the fall in blood pressure. The absence of vomiting in the post-anaesthetic period is also a desirable property.

On the other hand, there are disadvantages to be considered. At the present time, it is a very expensive agent. It causes respiratory depression, hypotension and bradycardia, its use with adrenalin appears to be unwise, and the relaxation it provides is not adequate for all kinds of surgery.

The probable uses to which it will be put will depend on personal preferences, and a variety of other factors. It may be used as an adjuvant to nitrous-oxide rather than trichlorethylene, especially for radical mastectomy, plastic and neuro-surgery where the reduction in haemorrhage would be an advantage. The depression of laryngeal reflexes makes it a useful agent for intubation, and some prefer it to succinyl-choline for this purpose. It is especially useful with children, because of the rapid pleasant induction it provides and in such patients with less powerful musculature, the relaxation is adequate for almost any procedure.

Recent work done by Orton (1958) has shown that it depresses body metabolism. This means that the respiratory depression it causes is probably less hazardous than it would otherwise be, and indicates a use for the drug as a replacement for, or supplement to current techniques involving pump-oxygenators or hypothermia to allow the circulation to be clamped off for varying periods of time.

In situations where nitrous-oxide cylinders are in short supply, for example in distant regions, or in the armed services where mobility is essential, then Fluothane would have a wide range of usefulness provided there were anaesthetists available who were adequately trained in its use. However, since the relaxation that it provides falls short of that provided by nitrous oxide relaxant sequences, it will probably attain only a limited popularity for anaesthesia for abdominal surgery. Although open inductions are wasteful, and deliver unknown concentrations, with Fluothane, they are very brief and smooth, and it may be preferred to ethyl chloride for this purpose. The change over to maintenance with open ether, or to Fluothane from a graduated vaporizer is almost invariably uneventful. Induction from vaporizers is almost as easy as the open technique, is less wasteful, and known concentrations are delivered, and it is therefore rather safer.

Thus it seems that this is a drug which is likely to achieve considerable popularity in many fields of anaesthesia, although not in all fields, because of the limiting factors detailed above.

ACKNOWLEDGEMENTS

I wish to thank Professor Sir Robert Macintosh, for encouragement, help and advice while working in the Nuffield Department of Anaesthetics, Oxford, and also Dr. R. Bryce-Smith, with whom I anaesthetized a large series of patients using Fluothane.

To Dr. H. G. Epstein and other members of the Department also go my thanks for their co-operation and assistance.

REFERENCES

BRENNAN, H. J., HUNTER, A. R., JOHNSTONE, M. (1957), *Lancet*, vol. 2, page 453.

BRYCE-SMITH, R. (1957), *S. Afr. Med. J.*, vol. 31, pages 44, 1115.

——— and O'BRIEN, H. D. (1956), *Brit. Med. J.*, vol. 2, page 969.

——— and O'BRIEN, H. D. (1956), *Proc. roy. Soc. Med.*, vol. 50, page 15.

CHANG, J., MACARTNEY, H. H., GRAVES, H. B., (1957), *Canad. Anaesth. Soc. J.*, vol. 4, page 187.

COLE, W. H. J. (1958), Personal communication.

EPSTEIN, H. G., and MACINTOSH, R. R. (1956), *Anaesthesia*, vol. 11, page 83.

FOSTER, C. A. (1957), Lancet. vol. 1, page 1144.

GIVEN, J. B., *et alii* (1957), *Canad. Anaesth. Soc. J.*, vol. 4, page 282.

HUDSON, F., *et alii* (1957), *Canad. Anaesth. Soc. J.*, vol. 4, page 221.

JENKINS, C. J., *et alii* (1957), *Canad. Anaesth. Soc. J.*, vol. 4, page 259.

JOHNSTONE, M. (1956), *Brit. J. Anaesth.*, vol. 28, page 392.

MARRETT, H. R. (1957), *Brit. Med. J.*, vol. 2, page 331.

MEDICAL RESEARCH COUNCIL REPORT (1957), *Brit. Med. J.*, vol. 2, page 479.

ORTON, R. H. (1958), Personal communication.

RAVENTOS, J. (1956), *Brit. J. Pharmacol.*, vol. 11, page 394.

——— (1956), Abstracts of communications 20th International Physiological Congress, Brussels, page 754.

STEPHEN, C. R., *et alii* (1957), *Canad. Anaesth. Soc. J.*, vol. 4, page 246.

SUCKLING, C. W. (1957), *Brit. J. Anaesth.* (in press).

VIRTUE, R. W. (1958), Personal communication.

THE SURGERY OF OTOSCLEROSIS

By Stephen Suggit

Brisbane

A COMPARISON of two methods of fenestration may seem academic since the advent of stapes mobilization, but the following results are not without interest.

About four years ago I began a series of fenestration operations using the closed one-stage method elaborated by Garson (1952) and Bauer (1953). Sixty-nine operations were done, but a Thiersch split thickness skin graft from the post-aural region was used to cover the fenestration in place of conjunctiva as described by Garson and Bauer. I gave a preliminary report of this at the meeting of the Otolaryngological Society of Australia in Melbourne in 1954. The technique is similar to the classical open fenestration, but less facial ridge is removed and the continuity of the meatal skin tube and tympanic membrane is carefully preserved. The head of the malleus was not removed, but the incus was removed in all but 12 cases. None of these 12 cases with retained incus are included in the results given below. In the earlier cases no absorbable packing was placed over the free skin graft, but in the latter cases a little gelatin sponge was placed over the graft. The last four cases, not included in the results, were done in two stages, a post-aural calcigex pack being placed over the graft and removed a week later. None of these variations in technique appear to have had any influence on the results.

The actual window has been made in the same way in the closed operations as in the comparative series of fenestrations with the open cavities. The endural incision has been used for the earlier cases in the open cavity series, but all the later ones have had a post-aural incision following the technique of Simson Hall.

I have taken for comparison my last 50 open cavity fenestrations and first 50 closed fenestrations, which have been adequately followed up. One or two promising cases in both groups defaulted in follow up and have been discarded. This lowers the absolute percentage of success in both groups, but makes no material difference between the two groups in the relative results.

I ceased any further work on closed fenestration a year and a half ago, and began a series of stapes mobilizations. The results of the first 50 mobilizations are included in the comparison, but the short follow up of four to sixteen months is inadequate and the mobilization results must only be regarded as provisional. All these mobilizations have been done by the indirect method, applying force to the neck of the stapes, using the unmodified Beck Lomag microscope.

All three series contain cases of all degrees of operability, but the distribution is reasonably similar in both. It will be noted (Tables

TABLE 1

Hearing loss or gain, average level for 500, 1,000 and 2,000 cycles	*Open cavity fenestration operations two to six years follow up*		*Closed fenestration operations two to four years follow up*		*Stapes mobilization three to sixteen months*	
10db. or greater loss of hearing	2		2		0	
No significant change	16		11		19	
10 to 19db. gain	15		21		15	
20 to 29db. gain	12	32	15	37	12	31
30db. or greater gain of hearing	5		1		4	
TOTAL		50		50		50

1 and 2) that the success in terms of social adequacy is less than success in terms of significant improvement above pre-operation level. The cases with secondary nerve deafness are largely responsible for this difference, as many of these in all 3 series, though obtaining a rise to the 30-35db. level, may have a poor result at 2,000 cycles. The subjective result is good, and as Simson Hall stated in his presidential address (1958) success or failure rests on wider and more practical grounds than social adequacy alone.

TABLE 2

Hearing level average for 500, 1,000 and 2,000 cycles	*Open cavity fenestration operations, two to six years follow up*		*Closed fenestration operations, two to four years follow up*		*Stapes mobilization four to sixteen months follow up*	
Worse than 35db.	23		20		24	
35 to 31db.	3	26	5	25	4	28
30 to 26db.	14		16		9	
25 to 21db.	8	24	8	25	7	22
20db. or better	2		1		6	
TOTAL		50		50		50

I have done the open cavity operation on a few fenestrations I have done since turning to stapes mobilization, because it seemed that the hearing results in the closed operation were inferior to those in the open cavity operation. This appears to be wrong and the results of these figures came as a surprise to me.

The discharging cavity

The worst feature of open cavity fenestration is the discharging cavity. Some cavities may heal and remain dry for two or three years, only to become infected in later years. It has appeared to me that a discharging cavity is a potential cause of poor results, particularly late falling off in hearing in fenestration cases which originally showed promise. The relation of hearing results to the state of the cavity in the 50 open cavity fenestrations given in Tables 3 and 4.

These figures indicate a relationship between cavity infection and a poor hearing result. By contrast the failures in the closed operation are nearly all initial failures. A large number of these gained 10 to 20 db., but fell just short of the 30 db. line. The number of cases deteriorating after an initial good result in the closed operations is similar to those in the clean cavity series of the open operations.

Troublesome bleeding during operation

In one of the closed fenestrations, haemorrhage at the close of the operation was responsible for the deterioration of hearing, but cases of troublesome bleeding at operation have been fairly evenly distributed between the successes and failures in both types of fenestration operation.

Other complications

One case of the stapes mobilization series developed a facial paresis on the seventh day following operation. This cleared up completely within two to three weeks. The audiogram on the sixth day following operation showed a considerable gain in hearing bringing him above the social adequacy level, and at this examination there had been no evidence of facial weakness. During operation he had been restless and excitable under the membutal premedication, and it is presumed that the delayed facial paresis followed post-operative oedema of the middle ear mucosa. Disturbance of taste due to traction on the chorda tympani nerve occurred in a number of the stapes mobilization series, but varied much in degree and did not persist after four weeks. This complication probably occurs more frequently than is realized. One stapes mobilization developed infection. Swelling of the external canal lining subsided within two weeks, and good hearing has been maintained for over a year.

No other complications than those already mentioned have occurred in either the fenestrations or the stapes mobilizations.

Improvement in the high tones

The striking feature in stapes mobilization compared with fenestration is the improvement in the high tones. In fenestration little if any improvement occurs above 3,000 cycles.

TABLE 3

Hearing loss or gain, average level for 500, 1,000 and 2,000 cycles	*50 open cavity fenestrations*			
	Clean cavity		*Dirty cavity*	
10db. or greater loss of hearing	0	7	2	11
No significant change	7		9	
10 to 19db. gain	10		5	
20 to 29db. gain	9	23	3	9
30db. or greater gain of hearing	4		1	
TOTAL		30		20

Usually 4,000 cycles is the turning point and above that frequency there is some degree of worsening of the hearing compared with the pre-operative, irrespective of the excellence of the result at lower frequencies. Looking back to Table 2, only 2 of the open cavity fenestrations and one of the closed fenestrations showed an average level for the speech frequencies of 20db. or less below normal. By contrast 6 of the stapes mobilizations gave results of this order (Fig. I). If the 30db. average had been extended to include not 500-2,000 cycles, but 500-8,000 cycles the balance of results would have been markedly tilted in favour of stapes mobilization. Halliday has observed that, with a noise box in the unoperated ear the hearing to conversational voice is better after mobilization than after fenestration, and suggests that, in addition to this gain in the high frequencies following stapes mobilization, after fenestration there probably occurs a degenerative change in the high tone frequencies followed by recruitment. I think there is yet a third factor to be considered. This is the restoration of normal damping mechanism of the middle ear. This mechanism of drum membrane, ossicles and tension muscles cannot function in stapes fixation since it is immobilized or in the presence of a new window in the lateral semicircular canal, since it is by-passed.

The conception of phase relationship

It is seen from the figures in the first two tables that a closed fenestration can produce hearing gains of the same order as an open cavity fenestration, and that it is not necessary to separate the new fenestration from the tympanic cavity and round window, in order to achieve this gain of hearing. Even more interesting are the results given by Rosen (1957-1958) for fenestration of the footplate of the stapes, in which in some cases the hearing is virtually normal. It is difficult to reconcile the theory of phase relationship with these observations.

Results of different operations on the same patient

In 22 patients a different operation has been done on the second ear to the first ear of each patient. Not all the operations on these 22 patients are included in the 150 cases in the preceding tables. The degree of deafness may vary in the individual patient, the period of follow up may vary widely, and the numbers are small, but they are shown compared in Table 5.

TABLE 4

	Open Cavity		*Closed Fenestrations*
	Clean Cavity 30 cases	*Dirty Cavity 20 cases*	*50 cases*
Hearing at no time reached the social adequacy level.	5	2	18
Hearing reached the social adequacy level but subsequently deteriorated.	6	13	7
Hearing maintained at or above social adequacy level.	19	5	25

TABLE 5

Open cavity fenestration in one ear, closed fenestration in the other ear.	Better result in the open cavity fenestration. 5	Better result in the closed fenestration. 2	No material difference. 5	Both results poor. 1
Open cavity fenestration in one ear, stapes mobilization in the other ear.	Better result in the open cavity fenestration. 1	Better result in the stapes mobilization. 2	No material difference. 0	Both results poor. 2
Closed fenestration in one ear, stapes mobilization in the other ear.	Better result in the closed fenestration. 1	Better result in the stapes mobilization. 3	No material difference. 0	Both results poor. 1

Revisions

One closed fenestration was revised. There was no trace of skin in the mastoid cavity. The fenestra was covered by a fairly thick mucosa with some synechiae. The original fenestra had closed by bone. This was reopened and covered with the lining mucosa. The hearing came up as well as in the first operation, but deteriorated as in the first instance four months later.

A stapes exposure was done on a patient with advanced otosclerosis on the worse ear which had previously had a closed fenestration. This was done at the wish of the patient. The stapes was found to be already mobile.

A stapes exposure was done on a patient who had had a closed fenestration with retention of the incus and an indifferent hearing improvement. The exposure was more difficult than in an untouched case. The result was a rise of 7db. in the speech frequencies, bringing this ear just up to the 30db. line. The result compared unfavourably with that from an open cavity fenestration done on the patient's opposite ear.

A stapes mobilization was done in both ears, the first operation proving a failure, and the second a success. The first side was revised, the stapes was found to be fixed.

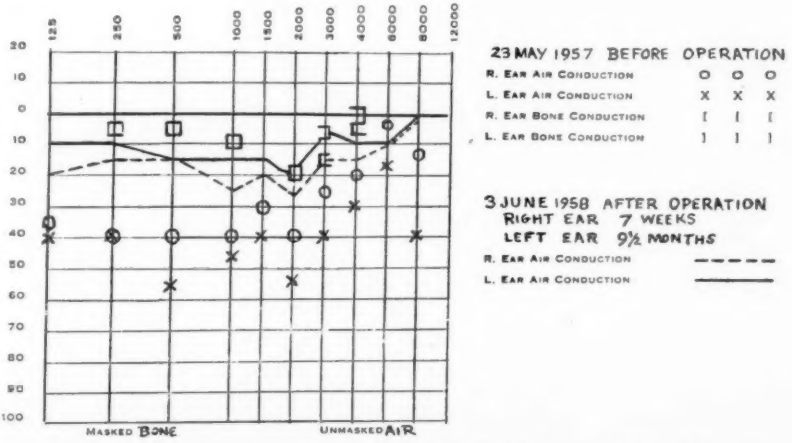

FIG. I. Girl aged 19 years: left stapes mobilization on the 27 Aug. 1957: right stapes mobilization 15 April 1958: Audiogram of 3 June 1958 shows the hearing level nine and one half months after the left operation and seven weeks after the right ear.

The stapes was moved without much effort, and mobilization was seen clearly. No hearing gain followed.

In three patients in whom stapes mobilization failed, open cavity fenestration was done later, and in all the stapes was found to be immovable. In all three a good immediate hearing result followed fenestration, but two subsequently deteriorated at the fourth to sixth month, presumably from bony closure, and both had infected cavities.

Fighting service personnel fall into the same category. I did a closed fenestration on an army officer some four years ago, but stapes mobilization is even more applicable.

I have been reluctant in the past to consider fenestration in patients under 20 years old, in view of the active repair in the young. Stapes mobilization does not seem to have this same objection, and I have mobilized several ears in the under twenties. These have had results above average. It may be argued

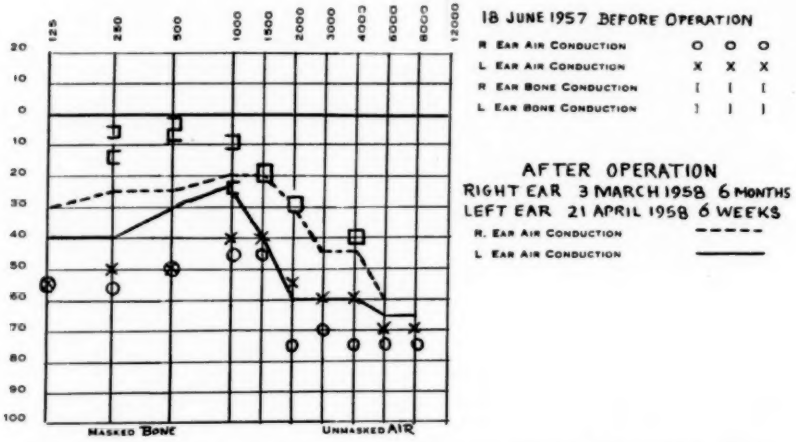

FIG. II. Locomotive driver aged 48 years: right stapes mobilization 3 Sept. 1957, facial paresis seven days following operation and completely recovered by the twenty-seventh day. Left stapes mobilization 4 April 1958. Audiograms of 24 March and 21 April 1958, shows the hearing level six months after the right operation and two months after the left operation.

The scope of stapes mobilization

I consider that stapes mobilization should be tried on both ears before resorting to fenestration. Stapes mobilization may be used in a number of instances, where fenestration is not justified. The patient, who had the delayed transient facial paresis following stapes mobilization on the first ear, was a locomotive driver. His chances of success with fenestration were poor in view of his bone conduction loss, the risk of making him worse was great (Fig. II). Moreover if an open cavity operation had been done, a discharging ear might have been added to his troubles and he would have lost his job. I advised him against surgery when I first saw him three years ago. This was a year before I first tried stapes mobilization.

that the otosclerotic process is not stabilized at this age, but if the stapes does again become fixed from recrudescence of the otosclerosis, the mobilization can be repeated.

I have always felt reluctant to fenestrate the patient whose hearing level is only 35db. below normal, since at best they are unlikely to gain more than 10db. Some of these patients find their moderate hearing loss a real disability. In this group there is a good possibility of raising their hearing level to 20db or better.

Finally there is the case in which one ear is strictly inoperable, or in which surgery has failed. Stapes mobilization, provided it is limited to the indirect method, that is force applied peripheral to the footplate, does not carry the hazard of fenestration.

Limitations

The limitations of stapes mobilization lie in the histopathology of the stapes ankylosis. Fowler (1957) has shown the varying form and degree of this ankylosis. It seems that in some cases mobilization of an adequate area of the footplate is impossible. For the hard core the future may lie in the more recent work of Rosen (1957 and 1958) in fenestration of the footplate itself.

REFERENCES

BAUER, F. (1953), *J. Laryng.*, vol. 67, page 56.

FOWLER, E. P. (1957), *Arch. Otolaryng. (Chicago)*, vol. 66, page 127.

GARSON, P. (1952), *J. Laryng.*, vol. 66, page 65.

HALL, SIMSON I. (1958), *Proc. roy. Soc. Med.*, vol. 51, page 57.

HALLIDAY, G. C. (1958), Personal communication.

ROSEN, S. (1957), *Arch. Otolaryng. (Chicago)*, vol. 65, page 217.

——— (1958), *Arch. Otolaryng. (Chicago)*, vol. 67, page 129.

SUGGIT, S. (1955), *Med. J. Aust.*, vol. 1, page 601.

CLOSURE OF TYMPANIC MEMBRANE PERFORATIONS

By F. Ellis

Sydney

THE methods mentioned in this short paper are by no means new, as is so with most medical and surgical discoveries. However, it is hoped that by airing some simple techniques, fewer tympanic membrane perforations will continue to exist.

The reasons for attempting to close such perforations are:—

1. Improvement of hearing.
2. Protection against external infection of the middle ear, e.g. from swimming.
3. Freedom from ear discharge with upper respiratory infections.

If the perforation is of recent origin, it will often heal spontaneously. If it is of long standing, several methods are employed, e.g.:—

1. Scarifying the edges of the perforation with escharotic solutions, such as trichloracetic acid.
2. Placing a prosthesis of some tissue over the perforation, to act as a scaffold for healing, e.g. amniotic membrane, thin paper, polythene sheet, cotton wool. This method can be combined with method (1) above.
3. Using patch grafts of split or full-thickness skin after first scarifying the edges of the perforation with special instruments (myringo-plasty).

Certain pre-requisites are necessary before these simple measures can be adopted:—

1. The perforation must be central. If there is no remaining tympanic membrane tissue between the perforation and the annulus tympanicus closure will not result from these techniques. Also, there must be no exposure of the handle of the malleus.
2. The perforation must be dry. However, the treatment can begin as soon as any cleansing regimen has been effective in clearing up suppuration.
3. There must be no active sinusitis or naso-pharyngeal disease.
4. The Eustachian tube should be demonstrated to be patent.
5. Any otitis externa present will need to be controlled first.
6. Smoking, sneezing, coughing and forcible blowing of the nose are all detrimental to the effectiveness of this treatment.
7. Finally, the perforation in its whole circumference should be visible through a speculum, as it is the whole edge that is treated. If some of the edge is inaccessible, then the treatment is not likely to be successful.

It is intended to deal chiefly with the method of scarification of the perforation edges by repeated applications of trichloracetic acid and with or without the aid of a prosthesis of paper, polythene, etc.

Rationale

Scarification causes a loss of the healed-over edge of the perforation, and the fibrous portion of the membrane is thus stimulated to heal. When it is sufficiently small, the epithelium will close the perforation completely. Such healing can be seen to take place even in perforations that have been present for many years. These healed perforations are no more liable to further breakdown than is any other scarred tympanic membrane, provided the Eustachian tube is patent. If the perforation is marginal or is in Shrapnell's membrane, or if the handle of the malleus occupies a part of the rim of the perforation, then other disease, e.g., cholesteatoma or bone necrosis, is likely to be present. In such cases some form of conservative mastoidectomy or tympanoplasty will usually be required. The method mentioned may, however, be used to deal with dry perforations of the pars tensa which exist following mastoid surgery.

Method

The method used by the writer is exactly this:—

No anaesthetic is necessary. A fine metal applicator with a wisp of cotton wool tightly wound with no fluffy ends is dipped into a solution of 50 per cent. trichloracetic acid. The excess of acid is removed by touching the tip on to a tissue. Under direct vision, the very edge of the perforation is dabbed until a white eschar about ½ to 1 mm. around the whole circumference develops. It sometimes helps to run the applicator around the inside edge of the perforation, care being taken to avoid the medial wall of the middle ear. A little chloromycetin powder can then be frosted over the perforation, and that completes that particular treatment.

The process is repeated at weekly or two-weekly intervals, until an assessment of progress can be made. Often the perforation can be seen to be closing. Before continuing further, it is sometimes necessary to remove debris from the rima of the perforation, so that the acid will take and form a proper eschar. As healing progresses, the treatment intervals can be spaced more apart until eventually the area is left to its own devices. It can then be seen that the final eschar tends to migrate posteriorly away from the perforation and when healing is complete the remains of the perforation can be seen on the posterior meatal wall as a circular scale.

If progress of healing is slow or if it appears to have ceased, then in addition to a painting with acid, a prosthesis can be applied. Usually, this is fashioned from a boiled-up piece of good quality notepaper such as is used for the writing of prescriptions, etc. It is cut whilst still wet and of such a size as to cover most of the tympanic membrane, and yet fit through the speculum. I usually hold it with a fine Lempert suction tip attached to the suction apparatus. The deep side of the paper is smeared with an antibiotic ointment. When it is against the drum-head, it will drop loose when the finger-tip control on the suction tip is released. It can then be tamped home with a wooden non-tipped applicator. Sometimes the outer surface of the paper is touched with a further small amount of trichloracetic acid. This will cause the perforation to be outlined through the paper. The prosthesis can be left for a month or longer, and not removed until it lifts away spontaneously from the tympanic membrane. Very frequently then, healing will have taken place.

Finally, if the perforation appears to have become larger as a result of atrophic changes in the tympanic membrane, the treatment is abandoned.

REFERENCES

DERLACKI, E. L. (1953), *Arch. Otolaryng. (Chicago)*, vol. 58, page 405.

ELIA, J. C. (1957), "Transactions of the Sixth International Congress of Otolaryngology," page 182.

CHOLECYSTECTOMY FOR ACUTE CHOLECYSTITIS

By Kenneth R. Cox

Melbourne

"I am not struck so much by the diversity of testimony as by the many-sidedness of truth."

Stanley Baldwin.

CHOLECYSTECTOMY for chronic cholecystitis was first performed by Langenbuch in 1882. Lilienthal performed a series of 13 cholecystectomies for acute cholecystitis with one death which he reported in 1904. Since that time controversy has persisted, with eminent advocates on each side, relating to the optimum time for surgical intervention.

Two main attitudes exist, then, on the management of cases of acute cholecystitis; one, of surgical intervention early if it is feasible and safe, the other of watchful expectancy in anticipation of spontaneous recovery. The methods and their protagonists are irreconcilable, for disadvantages beset both methods.

This analysis is presented to clarify the question of whether cholecystectomy at this stage is a sound or an ill-timed operation by examining the results of 108 cases of acute cholecystitis operated on between January, 1949, and December, 1954, at the Royal Melbourne Hospital. The group is selected in that these are public hospital patients. As a group they tend to present when symptoms persist, and they are not usually admitted to hospital unless a definite diagnosis has been made, or after a period of observation in the casualty ward has shown their lesion to be severe.

The diagnosis on admission was correct in 87 out of 108 cases, and the pre-operative diagnosis of the site of disease was correct in 98 cases. This selection and observation and subsequent histological examination of the gall-bladder separate these cases from bouts of "biliary colic with oedema."

Analysis of Material

Age incidence

More than two-thirds of the patients were over 50 with an earlier peak in the 30-39 group.

Sex incidence

Sixty-five of the patients were female, and 43 were male, i.e. a ratio of 3 : 2.

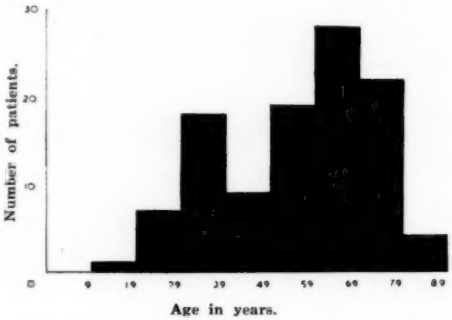

FIG. I. Age incidence at operation for acute cholecystitis.

Pre-operative pathology

These patients presented with a high incidence of pre-existing disease, totalling 117 ailments in 79 patients. Hypertension was marked in 54 cases and obesity in 31. Myocardial disease was apparent in 8 and respiratory disorders in a further 7 patients. Other diseases noted were diabetes mellitus, prostatomegaly, hepatic cirrhosis, hernia, peripheral neuritis, pernicious anaemia, schizophrenia, goitre, blindness and deafness.

Length of illness

To discuss early operation in acute cholecystitis, the timing must run from the onset of symptoms to the operation, not from the time of admission to hospital.

Seventy-six of the cases were operated on within seven days, mostly within seventy-two hours. However almost a third came to surgery later, at a stage where operative difficulties increase rapidly.

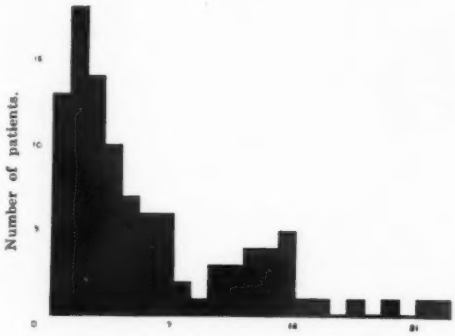

FIG. II. Interval between onset of symptoms and operation.

After admission to hospital, 96 cases were operated on within the first week of which the majority (64 patients) were performed within the first twenty-four hours. Of the 12 cases after seven days, 11 had initially been treated expectantly.

Anaesthesia

Most patients (80) had the advantage of relaxant and endotracheal anaesthesia. Regional block was used in one case and the remainder (26) received ether (these were either before 1950, or where the diagnosis was inaccurate).

Incision

Kocher's subcostal incision was preferred in 85 cases while 19 patients had right upper paramedian incisions. Transverse incision was used in another 3 cases, and one had a right lower paramedian incision with a stab wound under the right costal margin for a cholecystostomy. Eight patients were initially explored through a McBurney incision.

OPERATION FINDINGS

All cases were described as showing acute cholecystitis or its complications. Gangrene was observed in 17 cases, and this had proceeded to perforation in a further 14 cases. Empyema of the gall-bladder was noted in 15 patients.

The direction of perforation and the frequency of local abscess are seen in Table 2.

TABLE 1

Gangrene without perforation	17
Gangrene with perforation	14
Empyema	15
	46

It is instructive to note the length of history in these cases of severe pathology. In all histograms the time runs from the onset of symptoms to the date of operation.

TABLE 2

Peri-cholecystic abscess	7
Peri-cholecystic abscess with cholecysto-colic fistula	1
Acute free perforation	4
Acute free perforation with subphrenic abscess	1
Intrahepatic abscess	1
	14

FIG. III. Gangrene without perforation.

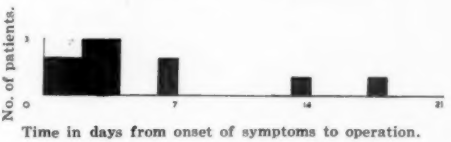

FIG. IV. Gangrene with perforation.

The cases of gangrene without perforation are crowded into the first few days with a maximum incidence on the third day.

The cases of gangrene with perforation are similarly but less strikingly rapid in onset. The 5 cases of acute free perforation had reached this stage exceptionally quickly. Two occurred in the first twenty-four hours, 2

more within forty-eight hours, and the last, which had established sub-phrenic pus, within seventy-two hours.

It is interesting to observe that only one of these was correctly diagnosed as choleperitoneum before operation. None of the localized perforations was diagnosed as such.

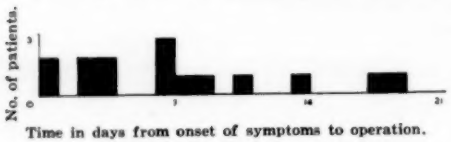

FIG. V. Empyema of the gall-bladder.

The cases with empyema of the gall-bladder are more drawn out, and have not come to surgery as urgently as the cases of gangrene.

Only 3 patients were correctly diagnosed as empyema out of 15, and this appellation was erroneously given to 6 others. Two of the 3 diagnosed empyemata had been observed in the ward for more than seven days.

OPERATION AND MORTALITY

Cholecystectomy was performed on 95 patients with no deaths. The common bile duct was opened in 12 patients, and stones were found in 7 of these.

Cholecystostomy was necessary in 13 patients of whom 2 died. The reasons for this operation are discussed later.

TABLE 3

	No. of Cases	*Deaths*	*Percentage Mortality*
Cholecystectomy	81	0	
Cholecystectomy and choledochostomy	12	0	0
Cholecystectomy and appendicectomy	2	0	
Cholecystostomy	13	2	15
	108	2	2

The first death occurred in a blind female aged 84 with symptoms for forty-eight hours who presented with general peritonitis and peripheral circulatory failure; at operation, acute free perforation of the gall-bladder with choleperitoneum was found.

The second death was of a hypertensive male of 74 with pain for twenty-two hours who also had choleperitoneum at operation; other autopsy findings were acute pancreatitis and pulmonary oedema. Both deaths occurred in 1949.

The rapid onset of gangrene and perforation without localization is well marked, and death cannot be attributed to the operation.

The mortality in cases with acute free perforation is 2 cases in 5 in this group, i.e. 40 per cent.

Operation hazards

Difficulty was reported in 7 cases, in 3 of whom operation had been delayed by expectant treatment.

Excessive bleeding occurred in 3 cases, two of which were attributed to a friable cystic artery.

The duct system could not be dissected in one case; in a second, the cystic duct could not be examined or the stone disimpacted in a case of acute free perforation; and in a third, stones in the common bile duct were extremely hard to find.

In another case a duodenal diverticulum was inadvertently opened.

Bacterial culture

Material was sent for bacteriological examination from 3 empyemata, 2 extra-hepatic abscesses, and 3 cases of acute cholecystitis. All except one empyema had been present for more than three days, and all except one acute cholecystitis grew organisms.

The bacteria implicated were coliform organisms or green streptococci, and the early empyema grew a mixed culture of *Clostridium welchii* and *Proteus vulgaris* in addition to *Eschericia coli* and *Streptococcus faecalis.*

Morbidity

A total of 43 complications occurred in 31 of the 106 patients who survived.

Ten patients suffered pulmonary infection or atelectasis.

Wound infection or haematoma followed in 7 cases. There was no case of wound disruption.

Three patients developed cardiac irregularities; one venous thrombosis, a transient hemiparesis and an acute glaucoma were also observed.

Shock was described in 4 patients, one of whom required a blood transfusion.

Three patients developed paralytic ileus (one with associated acute pancreatitis); distension was marked in one patient, while another vomited for twelve hours.

Two intraperitoneal abscesses required drainage, one in the right iliac fossa, the other in the right anterior subphrenic space.

Three males developed urinary retention, and suprapubic cystostomy was necessary for one of these.

Complications in the biliary tree are less well defined. One patient developed jaundice and cholangitis eight days after operation and this subsided. Profuse bile drainage was a problem in another after choledochotomy. In a third patient an abscess discharged pus and bile through the wound four months after operation. On clinical evidence a stone was presumed to have passed from the common bile duct of a fourth patient ten months later. Recurrent pain nine months after operation occurred in another patient.

There was no other evidence attributable to possible damage to the common bile duct, the shortest follow-up being for twelve months.

Pyrexia after operation

Some elevation of temperature occurred in all patients after operation for a variable time.

The majority had cleared in a week, but some persisted irregularly for over three weeks.

Forced operation

In 11 instances operation was necessary after a period of observation varying from one to three weeks.

Four patients had a persistent large mass; three patients had empyema of the gall-bladder; two more failed to improve on clinical evidence, and two developed jaundice with stones in the common bile duct.

Of these 11 patients operative difficulties were noted in three. Cholecystostomy only in one; tearing of the cystic artery in another with partial cholecystectomy; and in the third, common duct stones were hard to find and duodenotomy was necessary. After operation in this last patient occurred the complications of shock, profuse bile drainage and wound infection.

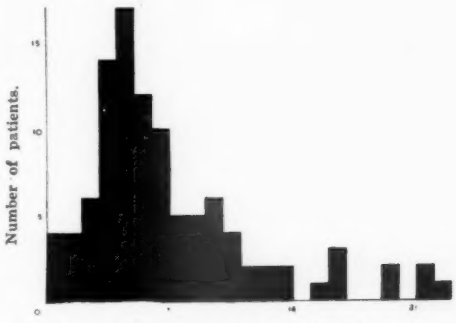

FIG. VI. Pyrexia after operation.

THE CASE FOR WATCHFUL EXPECTANCY

1. In the majority of cases the lesions resolve spontaneously or from a localized abscess.

2. Cellulitis is not best treated by surgery elsewhere, but should be allowed to resolve. Operation on an infected organ can cause dissemination. Surgery should be withheld until pus has formed.

3. Granted that gangrene and perforation do occur, but the patient gets better; the danger of these complications is less than that of early operation, and less than the same changes in other organs such as the appendix.

4. Operation is more difficult and dangerous with the risk of haemorrhage from a friable cystic artery and the attendant dangers of duct damage, and with the difficulty of definition of the duct system obscured by oedema.

5. Cholecystostomy might be necessary, and the patient then has two operations.

6. Common bile duct exploration might not be possible even though the indications are present. If the duct is explored there is

less certainty that the passages are clear, and that the opening into the duodenum has not been a false passage.

7. Emergency surgery allows no time for correction of the frequent associated diseases, and little enough for the defects created by this attack.

8. Most patients do not present to hospital until after two or three days have elapsed and discussion is centred by both sides on the minority where early operation is still possible.

If early operation were made a tenet of undergraduate teaching, this difficult operation would be increasingly performed by less skilled surgeons at an unfavourable stage of the disease; at a stage when more skilled exponents of early operation would regard discretion as the greater part of valour.

Similarly, removal of the gall-bladder can be made a point of honour and prestige, where a wiser surgeon is content to perform a cholecystostomy.

9. The mortality with conservative management is lower than with operative treatment.

THE CASE FOR EARLY OPERATION

1. This acutely inflamed organ is destined for removal sooner or later. It is subject to the same complications of obstruction in a closed circuit as the appendix, over which a similar controversy has almost resolved.

2. The outcome in an individual patient cannot be predicted; operation can be forced at a stage that is unfavourable locally.

3. The progress of the local disease is not validly assessible by clinical and laboratory data. Gangrene and perforation are frequently unassociated with recognizable evidence. Months after apparent subsidence, perforation or acute inflammation can be found.

4. The empyema, gangrene and perforation rates are higher than are generally appreciated. The mortality among conservatively managed patients can be reduced by prevention or early treatment of these complications.

5. The diagnosis might be wrong, and abdominal emergencies such as perforated ulcer or appendicitis can be more appropriately treated.

6. Acute cholecystitis begins as a chemical inflammation with bacterial infection supervening only after two or three days. Early operation will prevent rather than disseminate infection.

7. The patient is at risk on only one occasion, and two hospital admissions are avoided.

8. If early operation is shown to undergraduates to be feasible and safe, more patients will reach hospital in time for the procedure to be possible.

9. The mortality rate has been exaggerated by the selection of critically ill patients or delayed and forced operations, and by the deletion of the mortality of subsequent cholecystectomy among conservatively managed patients.

10. Perhaps a little defiantly, the operation is frequently easier, and the common bile duct can be explored if necessary.

DISCUSSION

The presentation of these results of operation does not provide any answer on the management to be preferred in any or all cases of acute cholecystitis. Such a study requires full controls on both schemes of management under comparable conditions.

However cholecystectomy for acute cholecystitis at the Royal Melbourne Hospital has been shown to have a low mortality and a definite morbidity.

Let us examine the validity of the points made on each side.

Spontaneous resolution

As with all features of this problem, a marked variation occurs in the previous reports. The more optimistic writers describe rates of 93 per cent. (Bachhuber, 1945), 90 per cent. (Pennoyer, 1938) and 74 per cent. (Berk, 1940).

Others show that the number coming to forced operation were 20 per cent. (Tournoff, 1934), 27 per cent. (Zinninger, 1932) and 32 per cent. (Kunath, 1937).

In this hospital during the same period 50 patients were treated expectantly of whom 11 came to forced operation (and are included above) and two died.

Insufficient evidence is available on patients treated recently to establish the frequency of complete spontaneous resolution and of clinical subsidence of symptoms; nor is there any correlation between attacks of acute cholecystitis and the findings at subsequent cholecystectomy.

It is a strong clinical impression that nearly all cases of acute cholecystitis settle down with minimal treatment. The disturbing feature is that more surgeons are describing in the literature how they have changed to early operation after reviewing the results of their conservative management.

Infective basis

A similar conflict of evidence makes this problem difficult to clarify.

Whipple (1935) showed that the gall-bladder contents were regularly sterile during the first two days and that infection was not a factor until a week had elapsed. Fallis and McClure (1940) had negative cultures from half the gall-bladders examined. Lester (1947) cultured bacteria from 28 per cent. of non-gangrenous gall-bladders and from 59 per cent. of gangrenous gall-bladders.

Yet Smith (1948) found 80 per cent. of all cultures positive.

Since, in the literature, the frequency of positive bacterial culture has not been correlated with the length of attack it is not possible to confirm or deny Whipple's position.

Nagner and Hutcheson (1932) highlighted a basis of apparent disagreement, confirming that bile inhibits bacterial growth and obtaining a higher percentage of positive cultures from the gall-bladder wall than from the lumen.

Thomas and Womack (1952) have demonstrated experimental acute cholecystitis by cystic duct occlusion with a gall-bladder containing bile, i.e. a sufficient mechanism has been achieved in the absence of infection.

Clinical evidence on the significance of any bacterial infection suggests that the problem is slight. The reported incidence of local inflammatory complications of surgery is quite small. In this series occurred two intraperitoneal abscesses, five cases of wound infection and one local abscess.

In general, then, the evidence for a bacterial cause or contamination is small in the early days of the attack.

The significance of gangrene and perforation

The frequencies of empyema, gangrene and perforation are variously quoted. Much has been made of the high incidence of such serious pathology and the lack of corresponding clinical evidence. Certainly the surgeon feels gratified in the accuracy of his clinical judgment when he sees dark patches on the gall-bladder wall.

In spite of all this data of previous experience, the significance of a gangrene and perforation rate over 25 per cent. is difficult to elicit.

Firstly, the cases are selected differently in each group. Some are restricted to critically ill patients or operations forced by progressive disease; in some the operation has been delayed for a week or so to allow the symptoms to subside; others refer to early operations where the word "early" is relative to the time of admission, not to the beginning of the attack; and lastly, some are operations early in the attack. The time relations of these changes to the beginning of the attack in this series can be seen in Figs. III and IV.

Secondly, it must be noted that surgeon and pathologist will frequently differ on the degree of change present. For example, Fallis and McClure (1940) demonstrated 66 cases in which the surgeon diagnosed gangrene of the gall-bladder which the pathologist recognized in only 29 instances. Discoloured patches on the gall-bladder wall are not necessarily equivalent to gangrene of the whole wall.

Thirdly, it is possible that the surgeon is a biassed witness. The separation of omentum from the gall-bladder can be a difficult process, and the perforation of the gall-bladder seen half-way through an operation is not necessarily the result of the disease.

If all cases of gangrene of the gall-bladder wall proceeded to perforation, then the expected perforation rate in conservatively managed cases would be over 25 per cent.

The lowest combined incidence of gangrene and perforation is 11 per cent. (Bachhuber, 1945), which he reduces to 7 per cent. by including the post-mortem frequency of these findings in patients not undergoing operation.

Now if we add the empyema rate of 13 per cent. (minimum figure, quoted by Bailey and Thrush, 1951), then the total frequency of serious pathology becomes over 38 per cent., i.e. 2 of every 5 cases.

revealed 12 with empyema and 6 with pericholecystic abscess.

These and similar figures (Judd, 1933; Touroff, 1934; Eliason, 1934 and 1944; Roscoe Graham, 1935; Heuer, 1937; Pennoyer, 1938; Glenn, 1939, and Fallis, 1940) support the observation that the clinical state and laboratory data of the patient do not necessarily parallel the pathological state of the gall-bladder.

TABLE 4

Series	*No. of Cases*	*Empyema rate (per cent.)*	*Gangrene rate (per cent.)*	*Perforation rate (per cent.)*			*Gangrene plus perforation rate (per cent.)*
				Unspecified	*Localized*	*Acute Free*	
Zinninger, 1932	78	..	..	..	..	..	21
Judd and Phillips, 1933	508	..	..	..	..	..	13
M. Smith, 1933	107	..	..	..	..	..	22
Touroff, 1934	75	..	..	..	..	..	20
Heuer, 1937	89	..	..	..	..	..	20
Kunath, 1937	103	..	..	..	23	4	27
Pennoyer, 1938	300	..	10	..	10	2	22
Glenn, 1939	219	..	8	19	..	..	27
Berk, 1940	3000	19	25	10	..	2.3	35
Cowley and Harkins, 1943	490	..	..	..	4	1	..
Eliason and Stevens, 1944	135	28	34	14	..	..	48
Bachhuber *et alii*, 1945	804	..	3	..	4	4	11
B. Smith, 1945	332	..	16	9	5	..	..
Marshall and Phillips, 1948	74	..	..	12	..	..	..
Eddey, 1950	105	15	15	..	7	5	28
Bailey and Thrush, 1951	76	13	16	..	8	4	28
Fletcher and Ravdin, 1951	600	..	..	5	..	1	..
Pines and Rabinovitch, 1954	1480	..	..	6	4	2	..
Morse *et alii*, 1957	542	..	..	5	3	2	..
Present Series	108	14	16	13	8	5	29

If this is reflected neither in the mortality figures of conservatively treated patients, nor in the frequency of forced operation, nor in the findings at subsequent elective cholecystectomy, it must be concluded that empyema, gangrene and perforation are not necessarily progressive lesions or as dangerous to the patient as the same pathological changes in other organs; or, alternatively, that the surgical diagnosis of the degree of pathological change is inaccurate.

This last proposition has been suggested above with respect to gangrene of the gall-bladder, and Fallis and McClure (1940) also showed 40 surgical diagnoses of empyema of the gall-bladder of which only 15 were proven pathologically. Andrews (1935) also felt that in most cases of empyema the "pus" was simply precipitated calcium or cholesterol.

The findings at subsequent elective cholecystectomy are often surprising. Kunath (1937) in a careful article showed that of 32 cases coming to elective surgery after satisfactory subsidence of clinical signs, operation

Exponents of early surgery feel this demonstrates the need for prevention and treatment by early excision or drainage.

The supporters of watchful expectancy hold it to demonstrate the relatively benign nature of such lesions.

Perhaps the increased difficulty at subsequent cholecystectomy is balanced by the opportunity to prepare the patient for operation carefully.

Doubts will centre most around preventible mortality from these lesions, and this is discussed later.

Operative difficulty

Cholecystectomy can be a tedious and difficult operation under ideal conditions. Errors in surgical technique have serious consequences to the patient.

Emergency operations do not allow time for correction of pre-existing lesions such as obesity, hypertension, myocardial and bronchopulmonary disease.

Dehydration and electrolyte depletion from vomiting, and acidosis from starvation require correction.

The surgeon must take stock of the ability of himself, his assistants, anaesthetist and nursing staff as well as the condition of the patient, before embarking on an operation where he is persistently harassed by obesity, inadequate retraction, poor lighting, inadequate relaxation and his own tiredness.

If the patient comes to surgery within two or three days of the onset of symptoms, then the operation can be easier than an elective cholecystectomy for chronic cholecystitis, especially following the technique described by Eddey (1950). Maingot makes the point that fibrinous adhesions are more easily dealt with than fibrous adhesions. Stripping the gall-bladder from the fundus down in the plane of oedema and taking the cystic vessels on the gall-bladder wall greatly reduces the difficulty and danger that can be associated with attempts to dissect around a large stone impacted in Hartman's pouch.

In this series operative difficulties were noted only 7 times, and in 3 of these the operation had been delayed in anticipation of spontaneous improvement.

Certainly cholecystostomy might be the only feasible operation and is indicated when:—

1. The condition of the local tissues makes removal unsafe;
2. the physical difficulties of obesity, illumination, anaesthesia and assistance impair exposure;
3. serious local complications such as jaundice or pancreatitis call for drainage, and
4. when surgery must be expeditious because of age or of renal, cardiovascular or pulmonary complications.

That is, the surgeon must realize his own limitations and those of his patient.

Eliason and Stevens (1944) found the factors forcing cholecystostomy in 105 instances were:—

Obscured anatomy	45
Poor general condition	24
Local abscess	16
Pancreatitis	11
Jaundice	9

The earlier the operation, the less often will cholecystostomy be necessary.

It is a little hard when cholecystostomy is forced as a life-saving procedure to describe it as a disadvantage of early operation. In this series the average delay from the onset of symptoms to cholecystostomy was six days, and the reasons given for that operation were:—

Pericholecystic abscess	5
Acute free perforation with poor general condition	3
Empyema and obscured anatomy	2
Cardiac failure and regional block anaesthesia	1
Cholecysto-colic fistula	1
Not stated	1

Unfortunately there is a marked lack of evidence in the literature on repair of damaged common bile ducts, which would indicate the relative frequency of damage in emergency and elective operations.

Exploration of common bile duct

Testimony on the ability to explore the common bile duct in cases of acute cholecystitis will vary with the timing of that operation relative to the onset of the attack.

Only one series (Marshall and Phillips, 1948) equals the frequency with which ducts are explored and stones found in that clinic in cases of chronic cholecystitis. For the others a number of explanations offer. The duct system can be so obscured that identification is not possible, or if identified cannot be examined adequately so that some indications for choledochotomy might be overlooked. It has been suggested that acute cholecystitis is so commonly caused by a single large stone that choledocholithiasis is less common in these patients.

Lahey (1940) was a strong advocate of choledochotomy in these patients, especially in the presence of jaundice, for if a stone caused jaundice after cholecystectomy for acute cholecystitis, then the next operation was dangerous and difficult.

These are not the only difficulties, and the position is summed up by Syme. "The common bile duct can be explored but it is very

difficult, and even more impossible than in the cold case to be sure it is clear, or that the opening into duodenum has not been a false passage."

TABLE 5

Series	*Ducts explored per cent. of total*	*Stones found per cent. of total*
New York Post graduate Hospital, 1927	17	14
Glenn, 1939, 1950	11, 9	5, 6
Berk, 1940	25	7
Marshall and Phillips, 1948	47	16
Dunphy and Ross, 1949	42	21
Eddey, 1950	14	7
Bartlett *et alii*, 1956	26	11
Present series	11	6

Mortality

The reported mortality in previous series has varied widely from 0 to 23 per cent. of all cases undergoing operation. Few of these series are comparable for they are inadequately documented or refer to different selected groups.

Heuer (1934) collected 36,623 cases of all types of gall-bladder operation. These showed an overall mortality of 6.6 per cent. while of 1,274 cases of acute cholecystitis, the mortality was 8.7 per cent. Heuer's own mortality of operation for acute cholecystitis at that time was 2.8 per cent.

Berk (1940) compared a 13 per cent. mortality among 1,744 cases after "early" operation with 6 per cent. mortality in 2,203 cases treated conservatively. At the same time the mortality for cases operated on within forty-eight hours was 2.7 per cent. (the lowest mortality in any group in that series), and those over forty-eight hours 11.1 per cent.

Glenn (1938) showed an overall mortality for operation on acute cholecystitis of 3.5 per cent, compared with 3.6 per cent. for cases of chronic cholecystitis in the same hospital.

The more recent series of Eliason and Stevens (1944), Marshall and Phillips (1948), Ross *et alii* (1950), Bailey and Thrush (1951) and Bartlett *et alii* (1956) describe a mortality not exceeding 1.5 per cent.

The mortality and the recorded operative difficulties have been shown to rise sharply with increasing time after the onset of symptoms (Graham and Hoefle, 1938; Ross *et alii*, 1950; McKenty, 1935; Heuer, 1934; Berk, 1940; and Eliason and Stevens, 1944).

Many testify to the high relative mortality in the later age groups (Smith, 1938; Glenn, 1938; Eliason and Stevens, 1944; Eddey, 1950) indicating that no gall-stone is innocent (Coates, 1948), and the mortality in this group will be reduced by prophylactic surgery when stones are first diagnosed (Pennoyer, 1938; Eddey, 1950; Bachhuber, 1945).

In many series even where the conservative attitude is maintained, there is a group of patients coming to operation within two days of the onset of symptoms because of the fulminating character of the disease. These are all elderly patients and acute free perforation without limiting adhesions is common (Fig. IV). Little disagreement exists on the management of these patients, but the mortality is distressingly high (16 per cent. of this early group and 30 per cent. of the total mortality in Eddey's figures (1950). Again preventive cholecystectomy would produce most improvement here.

Comparison of mortality with groups of conservatively managed groups is not valid due to the lack of recent series, the definite selection of patients in each group, the exclusion of the earlier fulminating cases and the later cases of forced operation, and the difficulty in establishing an exact diagnosis.

This is clearly illustrated by Pennoyer (1938) who presented the results of treatment of 300 cases selected as having been eligible for early cholecystectomy, but treated expectantly. Of these, 241 continued with conservative treatment with 5 per cent. mortality, while 59 came to operation with 25 per cent. mortality. This difference in death rate was argued as showing the danger of operative treatment, when clearly it showed nothing but the mortality resulting from the conservative attitude.

To what extent is the mortality preventible? Among expectantly treated patients, Pennoyer (1938) showed that at least half the deaths were attributable to complications after forced operation, but not to peritonitis from extension of local disease. Among Bachhuber's non-operative deaths, 44 per cent. had gangrene or perforation and 35 per cent. died from common bile duct complications. However, nearly half of Bachhuber's deaths occurred within two days of admission, and although no correlation has been made with the length of the attack, it seems likely that many had suffered fulminating attacks.

Among the groups treated by early operation, the mortality has been associated with the perforation rate, especially if unlocalized, and complications of associated pathology, especially pulmonary disease. As stated above, the death rate also varies with the age of the patient and the length of the attack.

Morbidity

Complications after operation are common, and in the series in which they are discussed (Smith, 1945; Glenn, 1946; Bailey and Thrush, 1951) occurred in a third of the patients. Pulmonary complications regularly account for a third of these, i.e. 10 per cent. of patients having cholecystectomy for acute cholecystitis. Damage to the biliary tree is apparently uncommon, even in the patently honest reports.

It is not possible to establish how often these complications were preventible, or to what extent the acute attack was responsible, or what the complication rate would have been had the management been conservative. Comparative figures for elective cholecystectomy are not available.

SUMMARY

1. The results of operation on 108 patients suffering from acute cholecystitis have been analyzed.

2. The bases of disagreement on the management of such cases have been discussed.

ACKNOWLEDGEMENTS

I wish to thank Mr. G. R. A. Syme and Mr. H. H. Eddey who first stimulated and encouraged my interest in this problem, and helped in the construction of this paper. The Staff of the Royal Melbourne Hospital kindly gave permission for their records to be used.

REFERENCES

AIRD, I. (1957), "A Companion in Surgical Studies." Edinburgh and London, E. and S. Livingstone Ltd. 2nd Edition, page 977.

ANDREWS, E. (1935), *Arch. Surg. (Chicago)*, vol. 31, page 767.

BACHHUBER, C. A., DEEB, P. H. and TAYLOR, E. A. (1945), *Amer. J. Surg.*, vol. 67, page 40.

BAILEY, H. A. and THRUSH, L. B. (1951), *Amer. J. Surg.*, vol. 82, page 328.

BARKSDALE, J. W. and JOHNSTON, J. H. (1948), *Ann. Surg.*, vol. 127, page 816.

BARTLETT, M. K., QUINBY, W. C., Jr., and DONALDSON, G. A. (1956), *New Engl. J. Med.*, vol. 254, page 200.

BEHREND, M. (1934), *Ann. Surg.*, vol. 99, page 925.

BERK, J. E. (1940), *Amer. J. digest. Dis.*, vol. 7, page 325.

BISGARD, J. D. and BAKER, C. P. (1940), *Ann. Surg.*, vol. 112, page 1006.

BLAND SUTTON, J. (1924), *Brit. med. J.*, vol. 2, page 795.

BLUMBERG, N. and ZIMMERMAN, L. (1945), *Amer. J. Surg.*, vol. 70, page 38.

BRANCH, C. D. and ZOLLINGER, R. (1936), *New Engl. J. Med.*, vol. 214, page 1173.

BRUGGEMAN, H. O. (1928), *Ann. Surg.*, vol. 87, page 423.

CARTER, R. F., GREENE, C. H. and TWISS, J. R. (1939), "Diagnosis and Management of Diseases of the Biliary Tract." Lea and Febiger, page 32.

CLAGETT, O. T. (1945), *Surg Clin. N. Amer.*, vol. 25, page 929.

COWLEY, L. L. and HARKINS, H. N. (1943), *Surg. Gynec. Obstet.*, vol. 77, page 661.

DUNPHY, J. E. and ROSS, F. P. (1949), *Surgery*, vol. 26, page 539.

EDDEY, H. H. (1950), *Roy. Melb. Hosp. clin. Rep.*, vol. 21, page 16.

ELIASON, E. L. and MCLAUGHLIN, C. W. (1934), *Ann. Surg.*, vol. 99, page 914.

—— and STEVENS, L. W. (1944), *Surg. Gynec. Obstet.*, vol. 78, page 98.

FALLIS, L. S. and MCCLURE, R. D. (1940), *Surg. Gynec. Obstet.*, vol. 70, page 1022.

FINSTERER, H. (1939), *Surgery*, vol. 6, page 491.

FLETCHER, A. G. and RAVDIN, I. S. (1951), *Amer. J. Surg.*, vol. 81, page 178.

GLENN, F. (1938), *Amer. J. Surg.*, vol. 40, page 186.

—— (1946), *Bull. N. Y. Acad. Med.*, vol. 22, page 384.

—— (1948), *Surgery*, vol. 23, page 397.

—— (1950), *Surg. Gynec. Obstet.*, vol. 90, page 643.

GRAHAM, H. F. (1931), *Ann. Surg.*, vol. 93, page 1152.

—— and HOEFLE, M. E. (1938), *Ann. Surg.*, vol. 108, page 874.

GRAHAM, R. R. (1935), *Canad. med. Ass. J.*, vol. 32, page 283.

HEIFETZ, C. J. and SENTURIA, H. R. (1948), *Surg. Gynec. Obstet.*, vol. 86, page 424.

HEUER, G. J. (1934), *Ann. Surg.*, vol. 99, page 881.

—— (1934), *Penn. med. J.*, vol. 37, page 370.

—— (1937), *Ann. Surg.*, vol. 105, page 758.

HEYD, C. G. (1937), *Surg. Gynec. Obstet.*, vol. 65, page 550.

JUDD, E. S. and PHILIPS, J. R. (1933), *Ann. Surg.*, vol. 98, page 771.

KUNATH, C. A. (1937), *Surg. Gynec. Obstet.*, vol. 65, page 79.

LAHEY, F. H. (1940), *Surg. Clin. N. Amer.*, vol. 20, page 793.

—— (1943), *Surg. Clin. N. Amer.*, vol. 23, page 639.

LESTER, L. J. (1947), *Surgery*, vol. 21, page 675.

LILIENTHAL, H. (1904). *Ann. Surg.*, vol. 40, page 44.

MCGURGAN, W. J. (1945), *Amer. J. Surg.*, vol. 68, page 219.

MARSHALL, S. F. and PHILLIPS, E. S. (1948), *Surg. Clin. N. Amer.*, vol. 28, page 633.

MORSE, L., KRYNSKI, B. and WRIGHT, A. R. (1957), *Amer. J. Surg.*, vol. 94, page 772.

MOYNIHAN, B. (1928), *Ann. Surg.*, vol. 87, page 424.

MUIR, J. B. G. (1946), *Aust. N.Z.J. Surg.*, vol. 16, page 14.

PARHAM, D. (1925), *Surg. Gynec. Obstet.*, vol. 41, page 367.

PENNOYER, G. P. (1938), *Ann. Surg.*, vol. 107, page 543.

PINES, B. and RABINOVITCH, J. (1954), *Ann. Surg.*, vol. 140, page 170.

ROSS, F. P. and DUNPHY, J. E. (1950), *New Engl. J. Med.*, vol. 242, page 359.

SAINT, J. H. (1943), *Surg. Gynec. Obstet.*, vol. 77, page 250.

SCHMITZ, E. J., SCHLOSSER, R. J. and HARKINS, H. N. (1953), *West J. Surg.*, vol. 61, page 459.

SMITH, B. C. (1945), *Surg. Clin. N. Amer.*, vol. 24, page 285.

SMITH, M. K. (1933), *Ann. Surg.*, vol. 98, page 766.

—— (1933), *Trans. Amer. surg. Ass.*, vol. 51, page 287.

—— (1938), *Surg. Gynec. Obstet.*, vol. 67, page 192.

SYME, G. R. A. (1957), personal communication.

THOMAS, C. G. and WOMACK, N. A. (1949), *Surg. Clin N. Amer.*, vol. 29, page 1445.

——, —— (1952), *Arch. Surg. (Chicago)*, vol. 64, page 590.

THOREK, M. (1934), *J. Amer. med. Ass.*, vol. 103, page 172.

TOUROFF, A. S. W. (1934), *Ann. Surg.*, vol. 99, page 900.

WHIPPLE, A. O. (1935), *Amer. J. dig. Dis.*, vol. 2, page 44.

ZINNINGER, M. M. (1932), *Ann. Surg.*, vol. 96, page 406.

FIBROSARCOMA OF THE SCROTUM

By Daniel Lane

Department of Surgery, Mater Hospital, Brisbane

FROM my reading of the available literature it would seem that fibrosarcoma of the scrotum is a very rare tumour. Tumours of the scrotum proper are always of great interest because they are so uncommon. I do not, of course, refer to the common sebaceous cysts and to the varieties of skin carcinoma which may occur in this site.

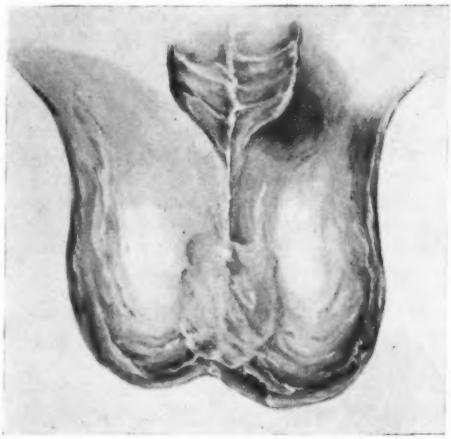

FIG. I. Drawing showing the position of the tumour.

Case report

J.M., aged 70, was seen privately on 5th December, 1957. He gave a history of a painless lump in the scrotum which had gradually increased in size during the past five years.

There was no suggestion of previous trauma. He suffered a recent attack of acute retention and at the present time experiences nocturnal frequency and increasing difficulty with micturition.

On examination he was seen to be a thin man in good general health. There was a hard mobile irregular lump in the scrotum about the size of a golf ball situated between the testes but not attached to them (Fig. I). The lump moved freely about within the scrotum. To the examining fingers the lump had the consistency of a uterine fibroid.

Rectal examination revealed an enlarged prostate. X-ray of the scrotum was normal.

A provisional diagnosis of fibroma was made.

Operation was performed on 13th December, 1957, under general anaesthesia using a mid-line incision in the scrotum. The lump was readily dissected out from its bed. There was no connection with either testis or epididymis.

The specimen consisted of a well-defined, hard, irregular tumour measuring 4 cm. in diameter. The cut surface was pinkish grey, firm in consistency and with an appearance of trabeculation (Fig. II).

Pathological report (Dr. George Taylor)

"The tumour is a fibrosarcoma with signs of activity" (Fig. III).

This opinion was shared by Professor Canny of the Queensland Medical School.

Follow-up

When seen on 11th March, 1958, his wound had healed soundly. In view of his age, the site and nature of the tumour, Dr. Cooper of the Queensland Radium Institute expressed the opinion that radiotherapy was not justified at the present time.

FIG. II. The tumour after removal showing its appearance on section.

COMMENT

Cade (1951) described a series of 153 patients suffering from soft tissue sarcoma, the largest recorded from a single source at the time.

The group, fibrosarcoma, accounted for 48 cases. The maximum age incidence was in the 3rd and 4th decades. The lower limb was by far the commonest site.

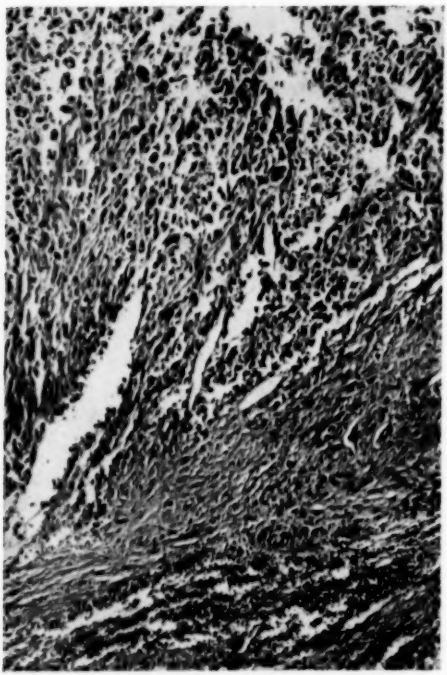

FIG. III. Photomicrograph of portion of the tumour showing transition from well differentiated collagenous connective tissue to cellular pleomorphic components. (x 64)

In the miscellaneous group described in Cade's series there is no mention of the scrotum as one of the odd sites. It would seem that the outlook in these sites is far worse than in the limb.

Fibrosarcoma is the commonest of the soft tissue sarcomata. All of these tumours are invasive, although the invasive characters are not usually apparent to the naked eye. The capsule which is often a feature is not a true barrier as the tumour cells have often penetrated it at the time of surgery.

Enucleation of the tumour will usually be followed by local recurrence and a more radical ablation should be performed. It would seem that wide local excision of these tumours in conjunction with the more modern methods of irradiation is the ideal form of treatment. If such is the treatment it is not uncommon to find survival periods of many years. Of course, the method of treatment will depend upon the histology and the site of the tumour.

The problem of treatment in the patient described is an interesting one especially in view of its anatomical site. I have been unable to find a comparable case in the literature. Kretschmer (1946) described a case of fibroma of the scrotum which presented in a fashion similar to the case described.

In this case report the author claimed to be able to find only two reported cases of scrotal tumours presenting fibrous tissue, one a lipomyxofibroma, the other a fibrolipoma.

An actively growing fibrosarcoma of the scrotum in a man of 70 poses a problem in management, but it would be far worse in a young man. In view of the clinical history of slow growth, the age of the patient and the tumour site, it has been decided to await further developments.

SUMMARY

A case of fibrosarcoma of the scrotum is described. This would seem extremely rare as it has not been possible to find any report of a similar case.

The problem of treatment is a difficult one and is influenced by many factors. In a case such as this the humanitarian aspect must also be considered.

REFERENCES

CADE, S. (1951), *Proc. roy. Soc. Med.*, vol. 44, page 19.

KRETSCHMER, H. L. (1946), *J. Amer. med. Ass.*, vol. 132, page 143.

PERCUTANEOUS PROSTATIC BIOPSY

By D. G. MACLEISH

Royal Melbourne Hospital

THE diagnosis of carcinoma of the prostate rests largely on physical signs. Whilst the experienced finger can assess with reasonable accuracy the underlying pathological process, physical signs remain at best an index of physical states. Clinical methods are no more accurate than they are with the breast. There are times when chronic and calculous prostatitis may simulate carcinoma, so that occasionally a biopsy is called for. Prostatic biopsy has been done by exfoliative cytology of prostatic smears, by exposure of the prostate through the perineum or anterior rectal wall, by transurethral resection, and by percutaneous needle aspiration. Although Pearlman (1955) has condemned needle biopsy, implying that following a negative result the surgeon is in a worse position than if he had relied on his clinical judgment alone, this method has been found incisively useful in a small number of cases. It is suggested that the procedure has a place comparable with that of needle biopsy of liver, kidney, lymph node and bone marrow, so that this communication reports its use in 35 cases and describes its technique and limitations.

Technique

Should the patient require a general anaesthetic for some other reason (e.g. haemorrhoidectomy), the procedure is conveniently done in the lithotomy position. As a rule, however, after emptying his bladder, the patient lies on his left side. The perineum is shaved from the anus to the base of the scrotum. The head is placed on a pillow, the trunk lying at right angles to the long axis of the bed or couch, with the buttocks overhanging its edge. The thighs are slightly abducted by a folded pillow between the knees, both of which are held well up to the chest. The perineum is prepared with an aqueous antiseptic solution. As the skin and soft tissues are infiltrated with local anaesthetic, the prostatic capsule is palpated with the needle and its depth assessed. The plunger of the syringe to be used for aspiration (a haemorrhoidal syringe will suffice) is withdrawn to include five cubic centimetres of saline in the barrel and to exclude air.

A minute stab is then made near the midline three centimetres anterior to the anus. The gloved, lubricated left index finger is then introduced into the rectum to palpate that part of the prostate from which a biopsy is desired. A ten centimetre, three pronged, modified Turkel needle is inserted through the stab, and directed upwards to the prostate. Pressure can then be transmitted from the left index finger in the rectum to the tip of the needle, so that its position and direction with regard to the suspicious portion of prostate can be gauged. The butt of the needle is then steadied with the thumb and middle finger of the left hand while the stylet is withdrawn. The needle is then advanced sharply with a screwing motion for three centimetres through the prostatic tissue (see Fig. I). The left index finger is now withdrawn and syringe and needle locked together. A strong negative pressure is rapidly developed, and maintained while the needle with its core of prostatic tissue is removed. As air enters the needle, the core enters the barrel, from which it is transferred to a clear glass jar containing formalin. The perineal puncture is covered with a sterile gauze pad and the patient left recumbent for one hour.

Results

Over the past five years, 35 biopsies were attempted. In 5, no prostatic tissue was obtained. Of these, one showed only blood clot, whilst another showed blood clot and flecks of calcium on the end of the needle from a patient who, as suspected at biopsy, was subsequently shown to have a calcified perineal membrane. In two, only fibrous tissue was obtained, presumably from the prostatic capsule, and in another, only skeletal muscle fibres and fat were detected. As experience increased, fewer negative results and better cores of tissue were obtained (Fig. II). There were 19 cores showing normal prostatic tissue, 8 showing carcinoma, and 3 showing calculous prostatitis. In 8 of the cases where biopsy had revealed normal prostatic tissue, subsequent prostatectomy allowed fuller pathological scrutiny of the gland, and in none of these was it necessary to revise the

diagnosis. In 3 of the cases where biopsy had revealed prostatic carcinoma, examination of material obtained by transurethral resection confirmed this, whilst in a fourth, done to elucidate the nature of a solitary bone lesion, widespread skeletal metastases subsequently developed. In two of the cases where biopsy suggested calculous prostatitis, radiological examination of the pelvis revealed prostatic calcification. In other cases, confirmation of the biopsy was not obtained, but clearly when this was done, the correlation was satisfactory.

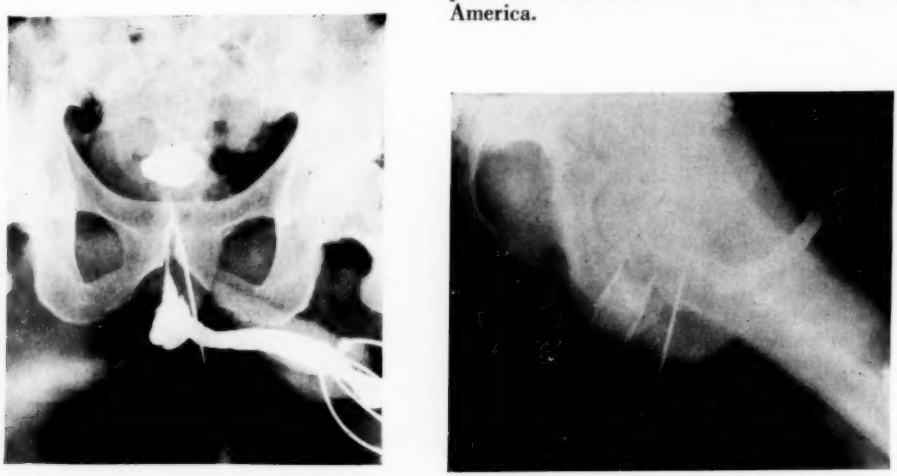

FIG. I. A.P. and lateral radiographs showing the relation of the needle to the prostatic urethra.

Complications

1. Haemorrhage

Following any needle biopsy there is some bleeding, but in no case in this series was it sufficient to cause symptoms. Two small perineal haematomata were noticed, but there was no haematuria, no increase in dysuria, and no perineal pain or induration.

2. Urinary Extravasation

Escape of urine, either into the pelvic connective tissue or under Colles' fascia, has been reported following prostatic biopsy. It did not occur in this series. Provided the bladder is empty, and the needle is advanced for a controlled distance, the risk of this happening is slight.

3. Infection

Suppuration in the biopsy wound, and epididymitis, have been recorded overseas, some of these possibly being the result of concomitant cytoscopy. Nevertheless neither proved resistant to treatment. No infection occurred in this group.

4. Miscellaneous

Urinary retention, reaction to local anaesthetic, and implantation of prostatic carcinoma in the perineal or rectal wound are rare complications which have been encountered in America.

Contra-indications

Certain factors make it unwise or impossible to attempt needle biopsy or, for that matter, any form of biopsy other than transurethral. Biopsy was therefore not attempted in the presence of the following diseases:

1. Infection, which took the form of infected prolapsed haemorrhoids, peri-anal suppuration, and perineal dermatitis.
2. Osteo-arthritis of a degree which prevented the flexion of the hips necessary to adopt the position for perineal biopsy.
3. Metastatic disease, either in the pelvis causing swollen painful legs, or in the femur causing pathological fracture.

Indications

Needle biopsy was found of special value in the following patient.

A.S.B., a sixty-three year old barber, was admitted to hospital for the investigation of a painful right tibia, of eight months duration. Radiological examination revealed an osteolytic neoplasm in the bone, but no other skeletal abnormality. An open biopsy of the tibia six months previously had suggested osteogenic sarcoma. A course of radiotherapy was given to the tibial lesion, but with little response. The prostate did not feel typically malignant, its sulci were distinctly palpable, and the serum acid phosphatase level was 4 King-Armstrong units. However, prostatic needle biopsy revealed spheroidal cell carcinoma, occult and with a solitary bone metastasis. Following bilateral subcapsular orchiectomy and stilboestrol therapy, the patient received temporary benefit, but succumbed with widespread metastases some nine months later.

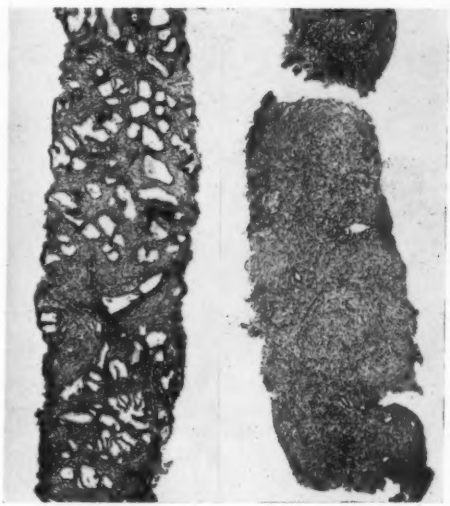

FIG. II. Core of tissue showing:
(a) Normal prostate, and
(b) Prostatic carcinoma. (x 32)

A further case in which biopsy was not done is of interest.

J.C., an otherwise healthy seventy year old metal worker, was admitted to hospital with acute urinary retention following twelve months dysuria. Clinically, his prostatic enlargement felt benign, although it was remarked that "if anything, it was softer than usual." Transvesical prostatectomy was advised. Although the enucleation began easily, a large portion of the gland was adherent to its capsule by soft sarcomatous-like tissue. The torrential haemorrhage which followed its removal required bilateral ligation of the anterior division of the internal iliac artery before it was controlled. After the operation, it was found that a biopsy needle could not be introduced into the inferior or posterior aspects of the removed gland without withdrawing anaplastic carcinomatous tissue. The lack of an initial biopsy was therefore regretted.

TABLE OF RESULTS

Tissue obtained	*No.*	*Percentage*
No prostatic tissue	5	14
Normal tissue	19	54
Prostatic carcinoma	8	23
Calculous prostatitis	3	9
Total	35	100

In general, prostatic biopsy may be of use in the following situations.

1. When the clinical findings leave doubt as to whether the gland is benign or malignant.
2. When the gland is clinically benign, but there is other evidence of malignancy, e.g. a high serum acid phosphatase level, or skeletal metastases.
3. To confirm a diagnosis of prostatic malignancy prior to orchiectomy.
4. In the evaluation of hormone treatment.

Limitations

Biopsy can demonstrate, but never exclude, prostatic carcinoma. Its simplicity, safety and speed make percutaneous needle biopsy attractive. However, it cannot compete in accuracy with open prostatic biopsy, since degree of accuracy depends on the size of the specimen obtained in relation to the size of the whole organ. Needle biopsy may fail to draw prostatic tissue or the portion may be too small to afford the pathologist a chance of giving a diagnostic opinion. For these reasons the surgeon must be prepared to disregard a biopsy which does not reveal carcinoma. Nevertheless, a biopsy showing carcinoma is of positive value, and justifies the negative biopsies which some authors regard as a waste of time.

SUMMARY

A series of 35 percutaneous needle biopsies of the prostate is reported. The technique is described, and its indications and limitations are briefly discussed.

ACKNOWLEDGEMENTS

I am indebted to the members of the Honorary Medical Staff of the Royal Melbourne Hospital, in particular Mr. W. E. A. Hughes-Jones, on whose patients the biopsies were done, and to Dr. J. D. Hicks, who examined most of the biopsy material. Miss Margery Powell generously helped in the preparation of the manuscript.

REFERENCES

BARNES, R. W., BERGMAN, R. T., and FARLEY, S. (1947), *J. Urol. (Baltimore)*, vol. 57, page 755.

CLARKE, B. G., LEADBETTER, W. F., and CAMPBELL, J. S. (1953), *J. Urol. (Baltimore)*, vol. 70, page 937.

CULP, O. S., and MCDONALD, J. R. (1954), *J. Urol. (Baltimore)*, vol. 72, page 443.

FERGUSON, R. S. (1937), *J. Urol. (Baltimore)*, vol. 37, page 774.

GRABSTALD, H. (1954), *J. Urol (Baltimore)*, vol. 74, page 211.

KAUFMAN, J. J., ROSENTHAL, M., and GOODWIN, W. E. (1954), *J. Urol. (Baltimore)*, vol. 72, page 450.

LAZARUS, J. A. (1946), *J. Urol. (Baltimore)*, vol. 55, page 618.

MELICK, W. F. (1951), *J. Urol. (Baltimore)*, vol. 66, page 408.

NEEDELL, M. H., SLOTKIN, G. E., MITCHELL, F. D., and FRIEDMANN, M. (1955), *J. Urol. (Baltimore)*, vol. 74, page 138.

PEARLMAN, C. K. (1955), *J. Urol. (Baltimore)*, vol. 74, page 387.

PEIRSON, E. C., and NICKERSON, D. A. (1943), *New Engl. J. Med.*, vol. 228, page 675.

RINKER, J. R., and SHUMAN, W. G. (1952), *J. Urol. (Baltimore)*, vol. 67, page 709.

VEENEMA, R. J. (1953), *J. Urol. (Baltimore)*, vol. 69, page 320.

FAMILIAL INTESTINAL POLYPOSIS ASSOCIATED WITH FURTHER ABNORMALITIES OF GROWTH

By P. J. KENNY and J. O'NEILL

Department of Surgery, St. Vincent's Hospital, Sydney

FAMILIAL intestinal polyposis is a disease entity that has been recognized for many years; according to Gumpel and Carballo (1956) the first description of the disease has been variously accredited to Menzel in 1721 and Virchow in 1863, and the inheritable nature of the disease was originally observed by Cripps in 1881. In more recent years the condition has been extensively studied by Cuthbert Dukes and his colleagues (1952a, 1952b, 1956) at St. Mark's Hospital, London. As a result of their studies, the course of the disease may be summarized briefly as follows:

(1) The onset of symptoms occurs at about the age of 20 years;

(2) Malignant changes supervene some fifteen years later, i.e., at about 35 years of age;

(3) Death from carcinoma follows in another six to seven years.

Recently attention has been drawn to an association of intestinal polyposis with other abnormalities of growth. In a series of papers, Gardner *et alii* (1951, 1952, 1953) reported six patients with polyposis coli who also presented with both "soft" and "hard" tissue tumours. The "soft" tumours were epidermoid cysts, fibromas and ill-defined masses of connective tissue. Different kinds were present in the same individuals. The "hard" tumours were osteomas.

In 1954 Oldfield reported a family suffering from multiple sebaceous cysts, three of whom developed polyposis coli.

In 1955 O'Brien and Wels reported six patients suffering from polyposis coli and benign fibrous tissue tumours and two of these (cases 4 and 5) also had an osteoma (of the right femur and right frontal bone respectively).

Also in 1955 Weiner and Cooper described a family group suffering from polyposis coli, "Soft" tissue tumours and osteomatosis. The osteomas occurred chiefly in the mandible and maxilla and the soft tissue tumours were widely distributed on the head, back, chest, abdomen and extremities.

In 1956 Gumpel and Carballo reviewed the literature and reported three cases showing respectively:

(1) Familial adenomatosis, osteomata, fibromata and fibrosarcoma;

(2) Familial adenomatosis and multiple epidermoid cysts;

(3) Familial adenomatosis, epidermoid cysts, subcutaneous fibromata and a leiomyoma of the small bowel.

They reported that in the earlier literature (Miller and Sweet, 1937; Pugh and Nesselrod, 1945; Guptill, 1947; Clark and Parker, 1950) cases of polyposis coli had been reported associated with other growth abnormalities, but it appears the association was not emphasized and was regarded as fortuitous.

From these reports it seems that there is a group of people who develop polyposis coli who also show other abnormal manifestations of growth. The latter may be divided into two varieties — "hard" and "soft" tissue tumours. The "hard" tumours are osteomata and occur chiefly in the mandible and maxilla. The "soft" tumours may be epidermoid cysts, fibromata, ill-defined masses of connective tissue, leiomyomata and fibrosarcomata. They may occur widely distributed in the subcutaneous tissues of the body, in the mesentery of the bowel, as retroperitoneal tumours, and in previous operation scars.

In many cases these "hard" and "soft" tissue tumours develop early in life before there is any evidence of polyps in the colon.

Hence their presence may be an indication of the future development of polyposis coli and so be an aid in the diagnosis of this disease and indirectly in the prevention of cancer of the large bowel.

Physical examination revealed a very well developed healthy looking person with five soft swellings, varying in size from 1 to 4 cms. in diameter, scattered over his chest wall and upper and lower limbs. Examination of his abdomen revealed no abnormality. Proctoscopy and sigmoidoscopy revealed

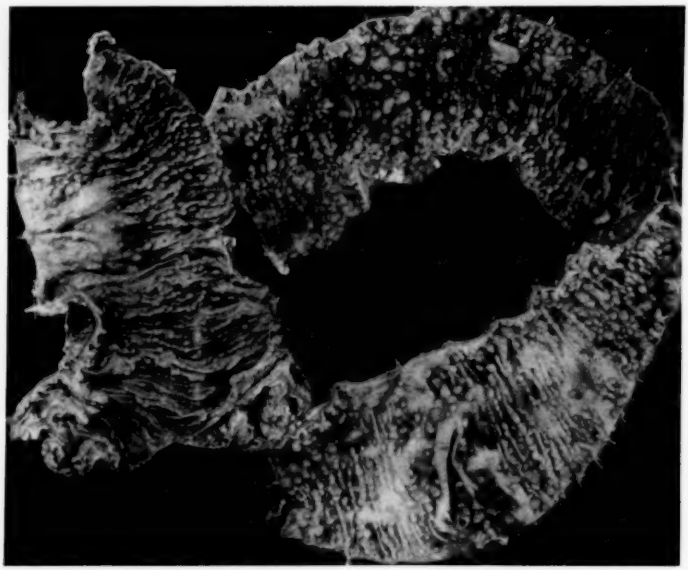

FIG. I. Specimen removed at operation on 27 February 1957 from T.S. showing mucosa of large bowel as far as upper sigmoid colon studded with numerous polyps.

Report of a family suffering from polyposis coli and "soft" tissue tumours

In February, 1957, Mr. T.S., aged 30 years, was referred to one of us (P.J.K.) by Dr. Fetterplace of Kempsey, N.S.W., with a diagnosis of polyposis coli. He gave a history of periodic attacks of diarrhoea and rectal bleeding for the previous seven years. These attacks would occur at intervals varying from three to six months and he had noticed that rectal bleeding would sometimes occur independently of the diarrhoea. Apart from this, his general health was excellent. Since childhood he had had 52 "sebaceous cysts" removed from numerous sites on his body.

Inquiries into his family history revealed the following interesting information:

(1) Several other members of his family suffered from multiple "sebaceous cysts".

(2) There had been a high incidence of death from cancer on the maternal side of his family. His maternal grandfather, three uncles and one aunt had died from cancer ("chiefly cancer of the bowel") and his mother, who is still alive, had had an operation in 1944 for cancer of the bowel.

the presence of a very large number of polyps in the rectum and lower sigmoid colon. An air contrast barium enema showed polyps scattered throughout the whole of the large bowel. His skeleton was X-rayed but no osteomata ("hard" tissue tumours) were found.

On 27 Feb. 1957, an ileostomy and subtotal colectomy was performed. Convalescence was a little slow but otherwise satisfactory. On 17 April 1957, a synchronous combined abdomino-perineal resection of the remaining sigmoid colon and rectum was carried out. At this time one of the lumps on his chest wall was excised. Convalescence was satisfactory and he was discharged from hospital on 19 May 1957.

Pathological examination of the various specimens was as follows:

"Received 72 cms. of caecum and colon. The entire mucosal surface is studded with adenomatous polyps, both sessile and pedunculated, the largest being 1½ cms. in diameter. There is no macroscopic evidence of carcinoma. Sections from four different areas show that these are benign adenomas with some evidence of hyperplasia."

"The specimen is an abdomino-perineal resection of rectum and sigmoid colon—33 cms. long. The mucosa of the bowel is studded with soft adenomatous polyps down to within 3 cms. of the anus. There are no features suggestive of malignancy."

"The specimen is a cyst containing thick white material—measures 2½ cms. in its longest axis. This is an epidermoid cyst."

FIG. II. Specimen of lower sigmoid colon and rectum removed at operation on 17 April 1957 from T.S. showing multiple polyps.

FIG. III. Low power view of one of the polyps in the specimen from T.S.

Since leaving hospital, Mr. T.S. has been seen at regular intervals and has remained very well. He states that his ileostomy does not inconvenience him at all, he has put on weight and he can carry out all the tasks he was capable of doing before his operation. His wife recently gave birth to their first child.

Family history

His mother, as mentioned previously, had an operation in 1944 for cancer of the bowel. Also, she has had more than sixty lumps excised from the surface of her body and still has 15-20 remaining.

He has four brothers and three sisters and efforts to interview and examine them resulted in three brothers and two sisters being

investigated at St. Vincent's Hospital and one sister being investigated and treated elsewhere. Efforts to interview the other brother have not been successful as he is living in the country at the present time.

The results of these investigations were as follows:

(1) Mrs. I.W.—aged 26 years—seen 29 May 1957.

She gave no history of any bowel symptoms or rectal bleeding. She had had four lumps removed from her body—one from the right arm and two from her scalp eleven years previously, and one from her left leg two years ago. Three years ago, she had had an operation for a ruptured spleen and then twelve months later had had a hernia through the lower part of the wound repaired and "a tumour on the muscle" removed at the same time. Pathologically, this had been reported as being a desmoid tumour.

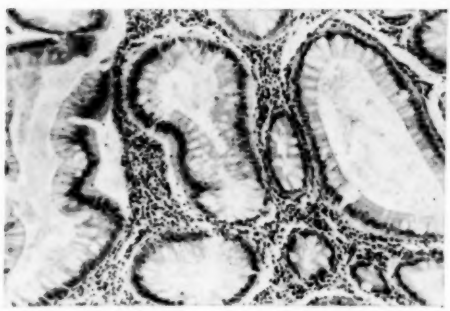

FIG. IV. High power view of polyp shown in Fig. III.

Physical examination revealed five "soft" tissue swellings now present—on front of the chest (1), right groin (1), right leg (2) and left arm (1) varying in size from 1-3 cms. in diameter. Proctoscopy and sigmoidoscopy showed polyps present in the rectum and sigmoid colon but not to such a marked degree as in the case of her brother (T.S.). An air contrast enema showed further polyps throughout the remainder of the colon.

On 23 July 1957, a subtotal colectomy and an ileo-rectal anastomosis was performed. The polyps present in the upper end of the rectum were diathermied before completing the anastomosis. A Meckel's diverticulum was also present and was removed. Post-operative convalescence was uneventful.

On 13 August 1957, the remaining polyps in the rectal stump were diathermied via a sigmoidoscope. She was discharged on 16 August at which time she was having 6-7 bowel movements per day.

The pathologist's report on the operation specimen was as follows:

"The specimen consists of 60 cms. of caecum and colon. The mucosal surface is studded with large numbers of small sessile polyps. A few are larger and pedunculated, the biggest being 2½ cms. in diameter. Examination of this large polyp shows it to be an adenoma without any evidence of malignancy."

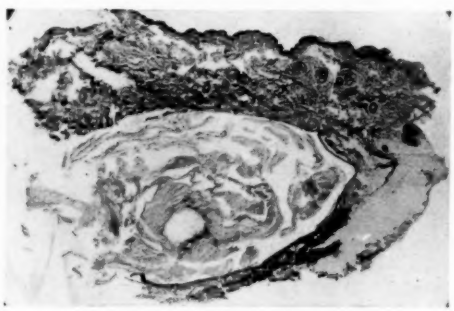

FIG. V. Low power view of epidermoid cyst removed from T.S.

Since leaving hospital, Mrs. I.W. has been well and her bowels now open 3-4 times a day. Sigmoidoscopy on 11 Feb. 1958 revealed two small polyps in the rectum. It is hoped to keep these and any others that may appear under control by diathermy, with the possibility in mind that should any evidence of malignancy develop, then removal of the remaining rectum and a permanent ileostomy will be required.

(2) Mrs. V.C.—aged 24 years—seen 5 June 1957.

She gave no history of any bowel symptoms nor had she had any lumps on her body. Her general health had been good.

Physical examination did not reveal any abnormality. Proctoscopy, sigmoidoscopy and air contrast enema were all normal.

(3) Mr. V.S.—aged 23 years—seen 17 April 1957.

He had had no bowel symptoms and no rectal bleeding.

Physical examination revealed two small "soft" tissue swellings on his scalp, one large one in the mid-lumbar region of his back and one small one on his left thigh. Proctoscopy and sigmoidoscopy showed a few small polyps present in the rectum. Air contrast enema was negative.

On 8 May 1957, the lump on his back was excised at his own request, as it was being constantly irritated by his clothes and braces. The pathology report on the specimen was:

"An oval cyst 5 x 2½ x 2½ cms. containing cheesy material. Microscopically, the lesion is an epidermoid cyst, similar to that removed from the patient's brother."

At the present time, this member of the family is being kept under regular observation. It seems likely that he will develop polyposis coli and that surgery may be necessary at some future date.

(4) Mr. C.S.—aged 19 years—seen 15 May 1957.

He has no bowel symptoms. He has had twelve lumps removed from varying sites on the surface of his body and has approximately ten present now—on the front and back of his trunk and on both upper and lower limbs—varying in size from 1-5 cms. in diameter. Proctoscopy and sigmoidoscopy showed one small polyp in the rectum. An air contrast enema suggested the presence of a small polyp in the descending colon and another in the sigmoid colon but was not conclusive. At the moment, he is being kept under observation as it seems likely that he will develop polyposis coli in the future.

(5) Master B.S.—aged 9 years—seen 15 May 1957.

This boy has had no lumps on his body and has had no bowel symptoms. He is being kept under observation.

(6) Another sister is known to have been investigated elsewhere and as a result had a subtotal colectomy and ileo-rectal anastomosis performed in 1957.

FIG. VI. Specimen of colon removed from Mrs. I.W. on 23 July 1957, showing multiple polyps.

SUMMARY

The condition of familial polyposis coli associated with "soft" and "hard" tissue tumours is briefly reviewed. A family group suffering from polyposis coli and multiple epidermoid cysts is reported. As far as we are aware, this is the first time this disease entity has been reported in this country.

ACKNOWLEDGEMENTS

Our sincere thanks go to Sister M. Regius of the Department of Clinical Photography for the reproductions of the various specimens, to Dr. John Garvan and Dr. Paul Lamond for the Pathology reports and to Dr. J. Rankin of Royal Prince Alfred Hospital for details of one of the members of the family under discussion. Finally, we wish to acknowledge the very devoted attention given by the nursing and resident medical staff of St. Vincent's Hospital in the care of these patients.

REFERENCES

CLARK, F. B., and PARKER, J. M. (1950), *J. Maine med. Ass.*, vol. 41, page 331.

DUKES, C. E. (1952a), *Ann. Eugen. (Lond.)*, vol. 17, page 1.

—— (1952b), *Ann. roy, Coll. Surg. Engl.*, vol. 10, page 293.

GARDENER, E. J. (1951), *Amer. J. hum. Genet.*, vol. 3, page 167.

———, and PLENK, H. P. (1952), *Amer. J. hum. Genet.*, vol. 4, page 31.

———, and RICHARD, R. C. (1953), *Amer. J. hum. Genet.*, vol. 5, page 139.

GUMPEL, R. C., and CARBALLO, J. D. (1956), *Ann. inter. Med.*, vol. 45, page 1045.

GUPTILL, P. (1947), *Surgery*, vol. 22, page 286.

LOCKHART-MUMMERY, H. E., DUKES, C. E., and BUSSEY, H. J. R. (1956), *Brit. J. Surg.*, vol. 43, page 476.

MILLER, R. H., and SWEET, R. H. (1937), *Ann. Surg.*, vol. 105, page 511.

O'BRIEN, J. P., and WELS, P. (1955), *N.Y. St. J. Med.*, vol. 55, page 1877.

OLDFIELD, M. C. (1954), *Brit. J. Surg.*, vol. 41, page 534.

PUGH, H. L., and NESSELROD, J. P. (1945), *Ann. Surg.*, vol. 121, page 88.

WEINER, R. S., and COOPER, P. (1955), *New. Engl. J. Med.*, vol. 253, page 795.

GALL-STONE ILEUS

By J. J. McCarthy

Royal Hobart Hospital

IT is to be regretted that while so much has been written about gall-stone ileus, so little has been told as to its methods of diagnosis. Radiological journals have played almost a sole role in this field, yet despite a few splendid articles late diagnoses continue to be made and little of significance has been done to reduce the mortality over the past two decades.

Such a state of affairs is surely a challenge to present-day surgeons, and just as surely no reduction in mortality will be achieved till three important facts are recognized.

1. That the condition, although infrequent is by no means as rare as generally considered.
2. That the policy of watching and waiting that is justified in some cases of intestinal obstruction should not apply here. The disease then is quite unlike the rather analogous condition of obstructing ureteric calculus. To pursue a "wait and see" regime when the diagnosis has been made can only lead to too frequent loss of one's patient, and dismay to all concerned. It should be always remembered that these patients need "looking into," and "looking into" early.
3. That the diagnosis may be aided, in not a small percentage of cases, by the typical X-ray findings. It is only when these are not present that Grey Turner's remark made over twenty-five years ago should still apply "that the disease is a pitfall for the practitioner."

Little need be said about the incidence, mortality and clinical picture as they are most adequately discussed by Brockis and Gilbert (1957) in a recent article. However, they will be briefly mentioned. It is about X-ray diagnosis that I intend to say more.

Incidence

Stanistreet (1953) in reviewing the records at the Royal Melbourne Hospital from 1941-1951 was able to discover only five cases of proven obstruction due to gall-stones. The disease occurred only twelve times in a series of 1,252 cases of intestinal obstruction reported by Smith (1955). This reveals a percentage of less than 1 per cent. of the cases reviewed.

Vick (1932) nevertheless pointed out that if one dissects a large series of cases of intestinal obstruction into various age groups it is possible to say that in a case of small bowel obstruction in people over 70 years of age in which strangulation may be excluded then the obstructing cause is a gall-stone in 23.7 per cent. of these people.

Mortality

Textbooks usually place the mortality rate of the condition as high as 40-50 per cent. In one series reported it was 60 per cent. Brockis and Gilbert (1957) reviewing all reported cases from 1920-1940 revealed a mortality of 57 per cent. From 1940-1956 it was still a severe but lowered one of 33 per cent.

Clinical features

The patients are usually somewhat elderly and more often females. In about half the cases a previous history of gall-bladder trouble is evident. The patient presents with an intermittent mechanical obstruction to start with which eventually becomes complete. No marked distension may be present clinically although at operation it may be quite considerable. At first much vomiting is in evidence and colicky pain is marked. Later on the vomiting becomes less and may even disappear for some hours but eventually returns and is of the faecal type. Cardinal signs being then early vomiting, then easing only later to return.

Constipation may or may not be present but frequently a bowel opening may occur early and then function ceases.

Aids to diagnosis

Much has been written on the significance of gas in the biliary tract in radiological journals but rather an inadequate amount in

surgical ones. Thus it is not surprising how often this important sign is missed. With the thought however, always in mind and a knowledge of what to look for, it will be found that the condition may be diagnosed more frequently on pre-operative radiological examination; and the X-ray need only be of the plain variety taken in several positions — supine, erect and lateral abdominal pictures.

Diagnostic X-ray signs are complete or partial obstruction with one or more of the following:—

(a) Air in the biliary tree. A sign that will be surely missed if not looked for.

(b) Change in position of a previously seen stone. Even one that assumes a horizontal position from its previously vertical one should be suspect (Figul, 1956).

(c) Visualization of a calculus in the intestinal tract. A sign also missed unless carefully looked for, if it is obscured by a skeletal shadow.

Air in the bile ducts is a common occurrence after short circuit operations involving the gall-bladder, and the mere presence of gas in the bile ducts does not mean gall-stone ileus but this together with intestinal obstruction does (Bridenbaugh, 1957). Despite the fact that gas in the biliary tract was first noted by Busi in 1919 many surgeons never think to look for this all-important sign. Not to do so will miss the diagnosis in quite a percentage of cases, the exact percentage being unknown.

Pathology

How does this gas enter the bile system? It is most frequently due to a cholecystenteric fistula, one most commonly between gall-bladder and duodenum, but it may occur between the gall-bladder and stomach, colon or small bowel. At other times it is due to incompetence of the sphincter of Oddi. Such a state of affairs is sometimes seen in cases of carcinoma of the sphincter or after a large gall-stone has passed through it and rendered it incompetent through overstretching.

Scott (1954) reports a case of gall-stone obstruction in which a gall-stone of 4" in circumference passed through the sphincter. Another similar case is reported with a stone having a diameter of 3.5 cm. and entering the digestive tract by a similar mechanism. How such a structure as the sphincter manages to dilate to such an extent must always remain a mystery to those who have tried to dilate it with sounds, or who have inspected it carefully at sphincterotomy.

When a fistula is formed it probably is due to inflammatory adhesions occurring between the organs concerned, plus pressure necrosis and the added influence of digestive ferments.

Site

Gall-stone obstruction may occur at the pylorus but this is rare. If obturation of the duodenal bulb occurs (rare also) it may be mistaken even at laparotomy for carcinoma due to its hardness, and gastro-enterostomy performed. Such a mistake is reported by Figul (1956). The most common site of obstructing stone by far is in the lower ileum, usually within three feet of the ileo caecal junction.

Treatment

This is essentially one of early diagnosis; instigation of aspiration by a suitable intragastric tube, rehydration, and planned surgery not too long delayed.

As no strangulation is present there is no great hurry, but it is wrong to delay in the hope that the stone will pass. It has been suggested that an associated low serum potassium may have previously played a part in the high mortality of the condition so serum electrolytes should always be done prior to operation and corrected accordingly. The operative technique is standard. A paramedian para-umbilical incision is usually used and the obstructing cause found. If possible the stone is milked a short distance upwards if it is not too firmly impacted and a longitudinal incision made, the obstructing stone removed and the bowel closed transversely.

A careful search should be made for a second stone particularly if the obstructing one is facetted. No search should be made to see the extent of the fistula other than palpation of the gall-bladder to see if it contains other stones, and if so these should be removed, if large, by a cholecystostomy and not cholecystectomy. Post-operatively

intravenous fluids and aspiration are continued till bowel sounds return. Severe wound infection is a fairly common post-operative complication and Brockis and Gilbert say it is to be expected in approximately 50 per cent. of cases.

FIG. I. Case 1: X-ray showing an oval laminated opacity, freely movable, in the lower abdomen.

Case 1

Mr. W.L., aged 71 years, was admitted to hospital on 25th November, 1956, as severe gastro-enteritis.

Past history. Coronary occlusion in 1955. Fatty dyspepsia for years. Severe colicky pain beneath the right costal margin four months prior to admission.

Present history. Dull ache on right side of upper abdomen radiating through to the back and pain becoming widespread. Vomited five times prior to admission. Vomiting ceased for twenty-four hours and then recurred. Slight abdominal tenderness noted but bowel sounds were normal. Constipation for three days. X-ray of abdomen revealed dilated small bowel with fluid levels and a laminated oval opacity freely movable in lower abdomen (see Fig. I).

Laparotomy revealed gall-stone obstruction in lower ileum.

Convalescence was complicated by infected wound.

Case 2

Mrs. F.L., aged 51 years, was admitted as a case of biliary colic on 23rd January, 1957.

Past history. Gall-bladder "attacks" for two years. Three months prior to admission severe colicky right upper abdominal pain followed by jaundice lasting ten days.

Present history. Colicky upper abdominal pain for seven hours. Vomited three times. Mild tenderness in abdomen. Slight jaundice was noted. Patient complained of diarrhoea. Vomiting ceased for twelve hours and then returned, faecal in type. Bowel sounds were accentuated and bowels now constipated.

X-ray. Few dilated coils of small bowel with fluid levels and gas noted in biliary tree.

Gall-stone obstruction in the lower 3 ft. of ileum.

Post-operative convalescence was uneventful.

FIG. II. Case 3: X-ray showing free gas in the biliary tree.

Case 3

Mrs. M.B., aged 77 years, waas admitted on 26th September, 1957, with intestinal obstruction.

Past history. Hemicolectomy for carcinoma of ascending colon three years previously. Heart disease for some years, treated for auricular fibrillation. No previous fatty dyspepsia or gall-bladder colic.

Present history. Two days history of severe colicky abdominal pain and copious vomiting. Bowel sounds accentuated.

X-ray. Several coils of dilated small bowel and free gas noted in biliary tree (see Fig. II).

Laparotomy revealed gall-stone obstruction in lower ileum. There was a grossly dilated small bowel and a large Meckel's diverticulum above obstruction. Stone was milked into diverticulum and both removed.

Post-operative period was complicated by a severely infected wound and the discovery that the patient was a diabetic.

SUMMARY

In these three cases that I have had the privilege of attending the outstanding features and conclusions are:

1. Three cases of gall-stone obstruction occurred in a period of less than ten months accounting approximately for 3 per cent. of all cases of obstruction in this period.
2. The operative mortality was nil, due possibly to X-ray diagnosis being made early in each case.
3. Gall-bladder dyspepsia was noted in two of the three cases and wound infection was severe in a similar number.
4. Unusual method of removal of stone in Case 3.
5. Although it is suggested that air in the bile ducts is a most important sign, occurring in two out of these three cases, it cannot be said that it occurs in 66 per cent. of cases. Brockis and Gilbert had only one such case in the twelve he reports (a percentage of 8.5). No one has a large enough series to say what the actual percentage is but it probably lies some where between these two figures. With a knowledge of what to look for it may be noted more often.

ACKNOWLEDGEMENTS

I should like to thank the Honorary Surgical Staff of the Royal Hobart Hospital for permission to report these cases and Dr. Drew, Medical Superintendent, for allowing me to produce this paper.

REFERENCES

BRIDENBAUGH, R. B. (1957), *Amer. J. Roentgenol.*, vol. 77, page 684.

BROCKIS, J. G. and GILBERT, M. C. (1957), *Brit J. Surg.*, vol. 44, page 451.

FIGUL, L. S. (1956), *Amer. J. Roentgenol.*, vol. 77, page 24.

SCOTT, M. G. (1954), *Brit J. Radiol.*, vol. 27, page 261.

SMITH, C. A. (1955), *Surg. Gynec. Obstet.*, vol. 100, page 651.

STANISTREET, R. H. (1953), *Aust. N.Z.J. Surg.*, vol. 23, page 73.

VICK, R. (1932), *Brit. Med. J.*, vol. 2, page 546.

ADVANCED CARCINOMA OF THE CERVIX UTERI WITH SURVIVAL BEYOND FIVE YEARS AFTER TOTAL PELVIC EXENTERATION WITH COLONIC SUBSTITUTE BLADDER

By GRAHAM GODFREY

From the Department of Obstetrics and Gynaecology, University of Melbourne

THIS is a follow-up report of a case which was included in a series published in 1954. It is presented to illustrate the degree and duration of the palliation that can result from a type of surgery which, on introduction, was thought to give useful, but only temporary relief.

FIG. I. L.B., 1958.

L.B., aged 58, treated first in 1949 by radon for carcinoma of the cervix uteri, was seen in August, 1952, with extensive residual growth in the cervix and the upper half of the vagina, complete fixation of the uterus in a "blocked pelvis," oedema of the bladder base, and slight bilateral hydronephrosis. Cervical biopsy showed squamous carcinoma. She complained of pain, discharge and bleeding.

FIG. II. Microscopic section of one of removed lymph nodes, showing metastasis.

During August and September, 1952, the Honorary Radiotherapist at the Royal Women's Hospital, Dr. W. P. Holman, irradiated the caecum and ascending colon by

the technique previously described (Godfrey, 1954), the purpose being to diminish secretion of mucus.

FIG. III. Operation specimen with bladder bisected and anterior walls of uterus, cervix and vagina laid open. Growth replaces uterus, cervix, and upper half of vagina. Invasion of bladder musculature can be seen. Regional lymph nodes and tissue removed by pelvic lymphadenectomy are not shown.

On completion of this treatment a substitute colonic bladder was constructed by the method described by Gilchrist *et alii*. The ureters were not transplanted at this operation.

In November, 1952, total pelvic exenteration, as described by Brunschwig, was performed. At the same time the ureters were transplanted into the substitute bladder, and a terminal sigmoid colostomy was made.

The removed material showed replacement of the upper half of the vagina and the cervix and corpus uteri by growth, invasion of the muscle of the bladder and rectum, and extensive metastases in the obturator, internal and external iliac nodes on both sides, as well as the left common iliac nodes.

She was discharged from hospital in December, 1952, and has remained in good health to the present date (July, 1958). She is an active person who lives alone, looks after herself, and enjoys social functions. She manages the substitute bladder without difficulty by catheterization at intervals of approximately 3 hours, and she is continent. The colostomy is well controlled. She wears only gauze pads, held in place by a light binder, over the ileal stump (which constitutes the substitute urethra) and the colostomy.

There is moderate non-progressive hydronephrosis with good renal function, and blood electrolyte estimations have remained consistently within normal limits.

REFERENCES

BRUNSCHWIG, A. (1948), *Cancer*, vol. 1, page 177.

GILCHRIST, R. K., MERRICKS, J. W., HAMLIN, H. H. and REIGER, I. I. (1950), *Surg. Gynec. Obstet.*, vol. 90, page 752.

GODFREY, G. (1954), *Aust. N.Z.J. Surg.*, vol. 23, page 161.

Books Reviewed

OPERATIVE SURGERY.

By CHARLES ROBB, M.C., M.Chir., F.R.C.S., and RODNEY SMITH, M.S., F.R.C.S. Vols. 3 and 4. London: Butterworth & Co. Ltd., 1957. 11¼" x 8½". Vol. 3: xii plus 96 pp.; 215 pp., Vol. 4: xiii plus 164 pp.; 144 pp.; 66 pp. illustrations. Price: £6 10s. per vol.

These volumes continue the presentation of operative surgery which is to occupy eight volumes. The method of presentation is essentially the same as for the previous volumes, which were reviewed in the August, 1957, number of this Journal (p. 75). An appropriate operation is chosen (and in some cases more than one) and this is illustrated by means of drawings. The various stages of the operation are clearly set out.

Volume III deals with rectum and anus and thorax. In the former the techniques range from simple proctoscopy to various forms of excision of the rectum and pilonidal sinus is also dealt with in this section.

In the part on the thorax, endoscopy of various kinds is given and such minor procedures as aspiration of the pleural cavity and artificial pneumothorax are considered. There is a section on the surgery of access and on certain operations of the chest wall. The remainder of the part is divided amongst the lungs, heart and great vessels, mediastinum and oesophagus.

Volume IV gives accounts of operations on the head and neck, vascular surgery in which is included the surgery of the sympathetic nervous system and the endocrine glands.

The operative descriptions are necessarily brief and the illustrations deal with what might be regarded as the ideal case. This, of course, was essential if the volumes were to be kept within reasonable size so when it is said that the illustration of procedures may be of great value in a perfect and typical case but that in one in which there are complications experience will be necessary to supplement the information given, this is not intended as destructive criticism.

The volumes, as their predecessors, are attractively presented and will be found of great value particularly to the younger surgeons. They should be of special value to those preparing for higher qualifications.

A SYNOPSIS OF OTORHINOLARYGOLOGY.

By J. F. SIMPSON, I. G. ROBIN and J. C. BALLANTYNE. Bristol, England: John Wright & Sons Ltd., 1957. 7½" x 4¼", 443 pp., 88 figures. Price: 42s. stg.

The abbreviated form of presentation is soon mastered, as it is no stranger to anyone who can recall the style of Lee McGregor's synopsis of surgical anatomy. In this small volume of 455 pages it is surprising just how completely each subject has been covered, and for this reason it becomes a reference book worthy of a place in any medical library.

Students of ear, nose and throat in particular will welcome the excellent presentation in the early chapters of the anatomy and function of the middle and inner ear. The difficult subject of labyrinthine disorder is dealt with briefly and to the point.

In Part 2, the "Nose" is given 18 chapters which allow a lot of detail not ordinarily found in a textbook. Included is a most useful chapter on the interpretation of sinus X-rays.

Sinusitis, always a difficult subject to classify and keep orderly, is logically tackled, and the role of allergy is well stated.

Treatment in all sections of the book is necessarily very brief, but is completely up to date. No attempt is made to describe the multitude of ear, nose and throat operations with all their modifications, but the principles of surgical management are stated for each condition, and generally a preference for one particular procedure is held.

ANAESTHESIA — A MANUAL FOR STUDENTS AND PHYSICIANS.

By STUART C. CULLEN, M.D. Fifth Edition. Chicago: Year Book Publishers, 1957. 8¼" x 5½". 295 pp., 37 figures. Price: $5.50.

This volume first appeared in 1946 under the title *Anesthesia in General Practice.* Much of the text remains the same, some has been deleted and some additional material added. As is explained in the preface, it is not the author's intention to provide "'pat' answers in specific problems." However, sound principles are set out which should provide the thoughtful student with a basis on which to build his knowledge.

The references at the end of chapters refer exclusively to the American literature. The reader could easily believe that no other country had contributed anything to the development of anaesthesia.

The author continues to use comic cartoons to illustrate his text. These are not in keeping with the quality of the reading matter that accompanies them.

This volume would give the reader an insight into most methods used today and would sound warning notes in places where over-enthusiasm is likely to be dangerous.

HOFTEALIOPLASTIK.

By R. MOUIN. Copenhagen: Egnar Munksgaard, 1957. 6½" x 9⅜". 275 pp., 90 figures. Price: 25.00 Danish Crowns.

This is an account of arthroplasty of the hip and includes a description of a special type of stem prosthesis that was used in suitable cases of fractures of the neck of the femur and in sequels of such fractures.

It is written in Danish apparently as a thesis for the degree of Doctor of Medicine. There is a summary and conclusion in English of 17 pages.

The basic idea is that arthroplasty is considered the corner stone in treatment of fresh or old fractures in "old" patients, and the type of prosthesis used should require only a minimal removal of bone so that a possible arthrodesis later is not made too difficult.

PLASTER OF PARIS TECHNIQUE.

By MARIAN ENGLISH, S.R.N., R.F.N. Edinburgh: E. & S. Livingstone Ltd., 1957. 8¾" x 5½", viii plus 126 pp., 133 illustrations. Price: 15s. stg.

Many who read this book will envy those fortunate people who learned their plaster technique at the hands of Mrs. English (Sister Newton). And some of them no doubt will wonder all the more why similar "plaster rooms" are not institutions in our own leading hospitals.

Splendid as this little volume is we feel that it just misses being a "classic," for a reason which, strangely enough, springs from the very perfection to which the author has brought the art of making plaster casts.

For instruction in plaster technique to the uninitiated, simplicity is the very keysone of success. Most experienced plasterers find only two sizes of plaster bandages necessary — namely 6" by 4 yards and 4" by 4 yards. Other sizes are superfluous and only cloud the issue. Complicated and intricately designed plaster slabs are of no real value; a plain slab, six layers thick, rolled to measure works well enough. Most hospitals and private practitioners, in this country at any rate, use Gypsona bandages, and while they remain available are unlikely to return to the old-fashioned hand-rolled articles. Finally while orthopaedic surgeons will read with great interest of Sister Newton's personal techniques, and may here and there find something of use they will, in the main, continue to use methods found satisfactory over the years.

They may even at times be a little critical. We do not concede that Gypsona casts do not last as well as those made from home-made bandages, nor that their setting time causes any real inconvenience when moulding of casts is required. We do not think it necessary to include anything more than the finger in the cast for the cure of "mallet" finger, and confess our almost invariable failure to maintain reduction in a true Bennett's fracture dislocation without the aid of traction for two or three weeks. Nor when using traction do we encounter any unfortunate sequelae in the shape of pulp wasting or infection if it is applied by means of silkworm gut and a suitable spreader, with continuous elastic traction by means of fine rubber tubing. We are more than surprised to find no reference in the text to moulding the foot proximal to the metatarsal heads — in fact one quite serious criticism that can be levelled at the otherwise excelent illustrations concerns the number of rather "boat" shaped feet that appear.

And having made these somewhat ungallant remarks we hasten to congratulate Sister Newton on a really excellent publication, which we can heartily recommend to anyone interested in high-class plaster work. And once again we sigh with a deep nostalgia for "the plaster room" and all it means.

ORTHOPAEDIC NURSING.

By MARY POWELL, S.R.N., M.C.S.P. Second Edition. Edinburgh: E. & S. Livingstone Ltd., 1956. 8½" x 5½", xii plus 440 pp., 271 figures. Price: 27s. 6d. stg.

The second edition of this book, written by one known far and wide as without peer as an orthopaedic nurse, will be welcomed by all concerned with the care of orthopaedic patients. Throughout its pages breathes the spirit of Agnes Hunt — to whose influence the author makes free acknowledgement in the preface. To one whose unit is part and parcel of a great teaching hospital, it is impossible not to be envious of those whose patients are cared for — body and soul — in the manner best described as the "Oswestry tradition."

One serious criticism that can be levelled at this volume is that it is too long. The subject — orthopaedic nursing — is large enough of itself without including many pages devoted to descriptions of aetiology, symptoms and management of the various diseases and conditions under discussion, which do much to swell the book to 440 pages. Of necessity such discussions are always incomplete, frequently inadequate and occasionally inaccurate enough to convey a wrong impression. One calls to mind the omission of osteoclasis and the mention of osteotomy in the management of ordinary bow-legs and, even worse, the whole discussion on the management of slipped upper femoral epiphysis. After all, this is a textbook on orthopaedic nursing, not orthopaedic surgery.

Miss Powell naturally excels in just those aspects of orthopaedic care that has made Oswestry world-famous — namely the fitting and management of the various frames and splints that were developed over the years by Robert Jones and Agnes Hunt. For clarity of description and meticulous attention to detail these chapters are unsurpassed. No one charged with the care of orthopaedic patients could possibly fail to learn, and learn a great deal, by reading and re-reading these passages. Moreover they are urged to so so. Particularly does the author merit praise for the innumerable little bits of "know-how" that appear from time to time — little hints which make all the difference between ordinary comfort and a feeling of complete happiness and well-being.

Special mention must be made of the illustrations which are both numerous (there are 271 of them), excellently chosen, and beautifully reproduced. Splints, with or without patients attached to them, have over the years, proved notoriously difficult to illustrate, usually fail to indicate the particular points of interest and generally end up by looking ridiculous. Miss Powell has overcome these disabilities to a remarkable degree — in fact there is an immense amount to be learned by simply turning the pages and looking at the pictures.

In this, of course, as in the production of the book she has been helped by E. & S. Livingstone Ltd., her publishers. One of these days, perhaps, we may be able to state that such and such a volume is not up to the Livingstone standard, but certainly not on this occasion. One other matter — what particular merit, may we ask, as the early morning air, that it warrants italics in the management of surgical tuberculosis? This, surely, is the voice of Florence Nightingale, rather than of Agnes Hunt. Or has the

smog of industrial Oxford caused her to forget the fragrance of honeysuckle and roses that was Oswestry?

INTRODUCTION TO DENTAL ANATOMY.

By JAMES HENDERSON SCOTT, D.Sc., M.D., L.D.S., and NORMAN BARRINGTON BRAY SYMONS, M.Sc., B.D.S. Second Edition. Edinburgh: E. & S. Livingstone Ltd., 1958. 8¾" x 5¾", xi plus 344 pp., 219 illustrations. Price: 42s. stg.

It is not surprising that a second edition of this useful work has been published since no other work in this field relates, so well, structure and function to clinical application. It is unfortunate, however, that, in an introductory text for undergraduate students, it has been considered necessary to increase the content by almost one-fifth in this edition.

The form and development of the human teeth and face are covered thoroughly but a consistent reference to the age of embryos at different stages of development would be less confusing to the student than a description based on C.R. stages.

While it is pleasing to find that consideration is given to the radiological appearances of the dentition during childhood, a single reference to the atlas of Symington and Rankin (1908) is quite inadequate and should be supplemented by the listing of more recent work such as that reported by Massler and Schour (1941) and by Gleiser and Hunt (1955). In addition, the range of variation in dental development as observed radiologically should be covered more fully.

Such statements as "in the upper jaw the developing teeth lie close beneath the orbital cavity, and the maxillary sinus lies on their inner side but has not yet grown outward over the teeth" (p. 117) show a looseness of phraseology which may be confusing to a student who is being trained to use precise terms when describing anatomical relationships.

The sections dealing with the eruption of teeth and with comparative dental anatomy are presented excellently and throughout the volume the quality of illustration is very good indeed. An oral surgeon would find it a useful addition to his library.

ANATOMIE DES MENSCHEN.

By A. WALDEYER. Berlin: Walter de Gruyter & Co., 1950. 9½" x 7". xviii plus 523 pp., 354 illustrations. Price: DM24.

The second volume of the *Anatomie des Menschen* is to hand. As the author remarks in his introduction, the exigencies of the war prevented its earlier appearance. The greater part of it was prepared in 1942, but, owing to fire and bombing and the fury of the war with its attendant destruction, it was necessary to do the work again.

This volume deals with the head and neck, the special sense organs, brain, upper limbs and the chest.

The illustrations are profuse, many in colour and in the best German tradition. The sections on surgical anatomy which appear in each chapter are especially useful. It would be difficult to isolate individual sections in the terms of superiority. A handy textbook of anatomy, written in German, it can be given its due meed of praise.

As in the case of the first part reviewed in this journal in 1957, the illustrations are reminiscent of Spalteholz and, that is, in itself, a sufficient commendation to older students of anatomy and those of a former generation.

The book is strongly bound in a linen-faced cover and is eminently suitable for the dissecting room. The many photographic plates and the excellent illustrations on almost every page are sufficient in themselves to recommend this product of detailed anatomical study and first-class lithography.

A CONTRIBUTION TO THE STUDY OF PORTAL HYPERTENSION.

By ALAN HENDERSON HUNT, M.A., D.M., M.Ch., F.R.C.S. Edinburgh and London: E. & S. Livingstone Ltd., 1958. 10" x 6¾", xi plus 230 pp., 120 figures. Price: 40s. stg.

This monograph, the Jacksonian Essay, Royal College of Surgeons, 1956, is a most valuable addition to the literature of portal hypertension, both for the physician and surgeon. It deals with all aspects of the problem in the clearest possible manner and of particular merit are the studies of the pathological anatomy in the portal circulation. The difficult problem of the emergency treatment of haemorrhage is clearly elucidated as is also the treatment of coma. This is a most rewarding account of an extensive experience and one to which repeated reference will be made by all engaged in this field.

THE BRITISH JOURNAL OF SURGERY.

Special Gordon-Taylor Birthday Number. Issued on the 18th March, 1958. Bristol: John Wright & Sons Ltd.

This number of the *British Journal of Surgery* has been dedicated to Sir Gordon Gordon-Taylor, K.B.E., C.B. It is the custom to dedicate special numbers of various journals to those who have been outstanding in their profession or who have made outstanding contributions to their specialities. This has been so in a number of cases as far as the *British Journal of Surgery* is concerned but in no case will it have brought the pleasure and satisfaction to members of the British Commonwealth in its outlying areas or in the Antipodes as will this number.

It is not proposed to review the Journal from the point of view of the material presented, although the papers in this number have been contributed by colleagues, friends and students of Sir Gordon's hospital — the Middlesex — and particularly his students and disciples from Australia.

Every Australian who went to London had reason to be thankful to Sir Gordon. The stories of his hospitality to individuals (the lunches and dinners at the famous hotels of London) are legion. As far back as the days of the First World War (as is indicated in one of the contributions to the number) Sir Gordon went out of his way to make it easy for the "colonials" to carry on their post-graduate work in London. He assisted many a struggling post-graduate to obtain a hospital position which enabled him to stay in England long enough to complete his post-graduate work.

On the other hand, he himself made several visits to the Antipodes. On these occasions, he was of inestimable assistance to the surgeons of this country, not only in bringing the latest views from other parts of the world but also, as the reviewer had good

reason to know, applied his own inimitable verve and special knowledge to problems of all kinds. He was directly responsible for the stimulus which gave rise to some of the advanced, even if not original, work which came out of this country in the last three decades.

In this part of the world we are delighted, in this special Gordon-Taylor birthday number, at the recognition not only of one of the great British surgeons of this century but of one who has done more for Australasian surgery and Australasian surgeons and thus for the better integration and continued interrelation of various parts of the British Commonwealth than any other individual or, indeed, any group of individuals of the present day. To quote the foreword to this number of the Journal, "We wish him very many happy returns of this birthday."

SIR CHARLES BELL, HIS LIFE AND TIMES.

By Sir GORDON GORDON-TAYLOR, K.B.E., C.B., F.R.C.S., and E. W. WALLS, M.D., Ch.B., B.Sc., F.R.S.(Ed.). Edinburgh: E. & S. Livingstone Ltd., 1958. 9" x 6¼", xii plus 288 pp., frontispiece and 49 plates. Price: 42s. (stg.).

There is no doubt that during the eighteenth century anatomical teaching in the British Isles was in the hands of Scots. This tradition was started in Edinburgh by Alexander Monro, *Primus* and *Secundus*, the fame of whose teaching drew students from most parts of the world, even away from Leyden which had held the ascendency in the previous century. Many of their students became prominent teachers in cities far removed from Edinburgh. But even before Monro *Primus* had been appointed to the Chair, James Douglas, also a Scot, was established as a teacher in London and was soon to become one of the most outstanding anatomists of his age.

The tradition established in both Edinburgh and London culminated in the work of the great William Hunter and his equally famous brother, John. William Hunter's school in Great Windmill Street produced more notable anatomists than any other in the British Isles. It is no exaggeration to say that modern anatomy was shaped in their hands.

From 1812 until 1826 the Great Windmill Street was owned by Charles Bell.

Charles Bell and his brother John were extremely gifted anatomists, both were skilled artists and together they produced the first modern English textbook of anatomy. Their *Anatomy of the Human Body* in four volumes, published between 1797 and 1804, developed from John Bell's *Anatomy of the Bones, Muscles and Joints*, 1793, and his *Engravings Explaining the Anatomy of the Bones, Muscles and Joints*, 1794. John wrote the second volume dealing with the heart and arteries for which Charles provided the illustrations, already published as a separate book; Charles wrote and illustrated the third and fourth volumes on the nervous system and viscera. Charles had also produced a magnificent atlas with the title *A System of Dissections* which was published in parts between 1798 and 1803. It is however in neuro-anatomy that Charles Bell will always be remembered; particularly for his work on the facial nerve and his experiments on the functions of the anterior and posterior spinal roots. There is no doubt that with the publication of his *Idea of a New Anatomy of the Brain* in 1811, he produced a classical text on neuro-anatomy even if some of his facts have now been proven wrong.

Much has been written about Charles Bell but the book now under review will certainly come to be regarded as the *definitive* biography. It is everything a biography should be, for it not only fits Bell into the surgical and anatomical background of his time but its many appendices, occupying nearly 100 pages, give all the factual details so often wanted in a biography but so seldom given. Bell's *Idea of a New Anatomy of the Brain* is reprinted in full so that modern readers may form their own opinion of its merits. This is important for the original printing was only 100 copies for private circulation. The whole of Bell's career is given with meticulous attention to detail and lavish use of illustration, the latter including some of his water-colour paintings of the wounded at Waterloo. Coupled with the better known facets of his life is the part he played in the foundation of the Middlesex Hospital Medical School so near to the heart of both authors of this book, the one as Consulting Surgeon, the other as Professor of Anatomy. Sir Gordon Gordon-Taylor is widely and very affectionately known in Australia for he has done so much for our young surgeons in London; Australian surgery owes him a debt which would be difficult to repay. That this book should appear during the celebrations of his 80th birthday is a matter for sincere and heartfelt congratulation. Charles Bell formed the subject of Sir Gordon's Vicary Lecture before the Royal College of Surgeons in 1954. We have waited a long time for its publication but he and Professor Walls, ably assisted by their publisher, have produced a really first-class book. It has obviously been a labour of love, but the authors can be justly proud of the result, for here is all of Charles Bell.

PRINCIPLES OF SURGICAL MANAGEMENT.

By H. A. F. DUDLEY. London: E. & S. Livingstone Ltd., 1958. 10" x 7", viii plus 203 pp., 68 figures. Price: 27s. 6d. (stg.).

This is a book of only 194 pages which should be read by every house surgeon before commencing his responsible position. It can be read in five hours and would then be referred to frequently.

Sound opinions are given on many minor problems of pre-and post-operative management such as recommending that smoking should be stopped at least ten days before operation, routine bronchoscopy after operations for perforated peptic ulcer, an increased mortality risk of 5 per cent. must be accepted when operating upon a patient with ischaemic heart disease.

There is a useful chapter on the use of antibiotics.

There are many useful suggestions for simple procedures such as anchoring drain tubes which are attached to negative pressure apparatus, passing and anchoring gastric suction tubes, removal of impacted faeces, and application of scrotal supports.

However, there are some features which are not realistic such as the implied ease of pre-operative emptying of the stomach in cases of pyloric stenosis, the treatment of cardiac arrest by an abdominal incision and massage through the diaphragm, and the general lack of details of treatment which would still require the house surgeon to consult his seniors.

It is a book which should be available in hospital libraries.